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CONTENTS.

	PAGE.
Supply of Humus to the Soil	189
Influence of Reaction of Nitrogen uptake by Tomato	190
Discovery and Introduction of the Amazon Fly	191
Observations on the Storage of various fruits and vegetables	196
Survival of Cane Borers in Trash	200
Variety Test on Sugar-Cane	201
Some Factors influencing decay in Florida Citrus Fruits	202
Obituary	202
Principles of Banana Breeding	203
Notes on Cover Crops in Dominica	209
Gold Coast Cocoa	209
Chimera in Dates	209
Notes on some Insect Pests in the Lesser Antilles	210
Root System of Coffea Arabica	212
Reviews	213
Sugar Notes	214
Chemical Notes	215
Market Notes	216

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SUPPLY OF HUMUS TO THE SOIL.*

MODERN Agricultural research is not only producing an increasing body of evidence tending to emphasize the necessity for the supply of humus in tropical soils, but is also engaged in evolving and testing the steps by which this humus may be obtained. The ideas which held the field during the past century, that the supply of plant food to growing crops was merely a question of economics, and that mineral fertilisers could be used to replace almost completely the organic manures which had hitherto been the only form available, are being displaced by the realisation that the soil is a scene of intense biological activity, and that soil treatment must take into account the need for maintaining a healthy physical condition, thus ensuring a correct environment for the biological activities of the soil. In short, the whole problem has been lifted from the realm of pure Chemistry into that of Biology. The argument is not that mineral fertilisers are unnecessary, but that they are more correctly used to supplement organic manures, and that the replenishment of the stores of humus in the soil is the first necessity. It is not only that heavier yields are obtained, for some striking results obtained from the permanent manurial plots at the Agricultural College Farm at Coimbatore in South India showed that the seed obtained from the plots manured continuously with farmyard manure produced a very much better crop than the seed obtained from the plots manured continuously with minerals only, or those not manured at all.

The absolute necessity for an organic basis for any successful manurial system once established, it becomes imperative to examine all possible sources of this material. It may be doubted whether Sir Albert Howard, among his many services to tropical agriculture, ever rendered one of more value than the study which he made of the problems of humus production, culminating in the evolution of what is called the 'Indore Process' (1). It can of course be argued that he was only voicing opinions that were already well known, and that he was only doing what every farmer had been doing for years, but the value of his work lies in the energy with which

* The Supply of Humus to the Soil. F. K. Jackson, Y. D. Wad and V. G. Panse. *Empire Cotton Growing Review*, Vol. XI, 2. The Sanitary Disposal and Agricultural Utilization of Habitation Wastes by the Indore Process. F. K. Jackson and Y. D. Wad. Institute of Plant Industry, *Bulletin No. I*, Indore, Central India.

he tackled the problem and the definition which he gave to a plan of action. It is most fortunate that his successor has followed up his work with enthusiasm, and from the stage in which Howard left it has developed the system in two directions, a simplified process adapted to dry areas where farming is of the extensive type, and a second modification to deal with what are universally called 'habitation wastes'.

With regard to the first, the authors consider that any impression of complexity such as might have been conveyed by the standard Indore Process must be avoided if the system is to be widely adopted, though they realise that such simplification necessarily implies some loss of quantity and a sacrifice of quality. Accordingly, they give, in commendable detail, an account of a simple process suitable for a small peasant holder, workable with only a few inches of rainfall. So far as it has been possible to test these ideas here, during the prolonged dry season which we are at present experiencing, they appear to be sound.

Turning to the question of 'habitation wastes', it is surely no credit to scientific agriculture that until recently it has left the question of their disposal almost entirely to the Health Officer or the Sanitary Engineer. These officers are interested in disposing of such wastes promptly, cheaply, and with the production of as little nuisance as possible in the way of noxious odours and the breeding of flies; they are not concerned with any loss of fertilizing ingredients that may occur. There are signs, however, that the agriculturist is at last waking up to the very heavy waste incurred in the methods that have hitherto found favour, and is realizing that as the population of the countryside moves more and more into towns and villages, this waste will continue to increase.

The importance of the problem may be gauged by the figures quoted by the authors, which show that the average annual amount of such waste for each individual is in the nature of 200 lb. organic matter containing 15 lb. nitrogen, nearly 4 lb. potash, and over 5 lb. phosphoric acid. It is true that the Chinese and Japanese have for centuries (2) been returning these wastes to the land by methods which are economical but hardly sanitary. The Activated Sludge Process, the invention of Dr. Fowler, is a modern method of dealing with sewage, in which it is possible to utilize the fertilizing material in a sanitary and convenient form; but the process implies a water-borne sewage system, is comparatively expensive to maintain, and so for the present is an impossible consideration for most towns in the Tropics.

In these circumstances, Jackson and Wad claim to have evolved a process which satisfies both sanitary and agricultural requirements. The resultant manure, in the shape of a dry innocuous powdery substance, is produced within a month in an amount approximating 50 per cent. of the original volume of refuse; it contains about 40 per cent. of moisture and weighs about 66 lb. to the cubic foot. It has been used on most of the common crops, both in the Institute at Indore and by peasant farmers, and the results are in every case reported satisfactory. From the sanitary point of view, two medical officers of the I.M.S., one the Director of Public Health in the Holkar State, and the other the Chief Medical Officer in Central India, vouch for its success, primarily as a disposal system, but also on the ground of its economy.

A very considerable measure of success has already been obtained in India in the practical application of such methods. The first large scale trial was made in Mysore City, and to those who know India it may come as a surprise to learn that thousands of tons of compost have been made from that city's refuse, using night soil as an activator; this manure sells at about four shillings a ton, and has been successfully used for the manuring of sugar-cane. The Indore Process, which closely follows the Mysore system, is now being successfully operated in a town with a population of 60,000 inhabitants, and here too the product finds a ready market.

Conditions in India are undoubtedly in certain respects peculiar, but there is no doubt that much could be done in the conservation of such wastes in other tropical countries by converting them into 'Agricultural Wealth'. Humus we must have, and this important source cannot continue to go untapped.

References.

(1) Howard, A. and Wad, Y. D. (1931). The Waste Products of Agriculture, their utilization as humus. *Oxford University Press*, London.

(2) King, F. H. (1926). Farmers of Forty Centuries or Permanent Agriculture in China, Korea and Japan. *Jonathan Cape*, London.

Influence of Reaction on Nitrogen Uptake by Tomato.

In a recent paper in *Soil Science* (Vol. XXXVII, 1934, pp. 203-225), H. E. Clark and J. W. Shive have described the results of their experiments on the rates of absorption of ammonium nitrogen and of nitrate-nitrogen by the tomato plant growing in water culture solutions of different pH values. For plants grown to the age of 41 days, the rate of absorption of ammonium from solutions of high pH value (alkaline reactions) was greater than from solutions of low pH value. The reverse was the case for nitrate, which showed maximum uptake at pH 5.0, representing a high degree of acidity. Under neutral conditions (pH 7.0), ammonium was absorbed more rapidly than nitrate. With plants 52 days old, the general results were similar, except that the influence of reaction on nitrate uptake was less marked. For increasing age of plant, the rate of absorption of nitrogen, per unit weight of plant tissue, diminished in the case of ammonium, but increased in the case of nitrate.

THE DISCOVERY AND INTRODUCTION OF THE AMAZON FLY.

A New Parasite for Cane-Borers (*Diatraea* spp.).

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1.—Introduction.

For some four years the writer had, among other projects, been searching for a borer-(*Diatraea*) parasite suitable for British Guiana cane-field conditions. The Cuba fly (*Lixophaga diatraeae*, Towns.) had already been studied in the Greater Antilles and introduced from Cuba into the Leeward Islands. It was considered a very efficient parasite, but one not likely to adapt itself to Demerara cane-fields, so different ecologically from those of Cuba.

2.—Discovery and identification of the Amazon fly.

In 1932 an expedition was made up the Amazon and across the Rio Branco savannahs to Venezuela, with the primary object of finding a froghopper parasite for Trinidad. To this end the project was partially financed by the Trinidad Sugar Cane Investigation Committee, but the main funds were derived from the Empire Marketing Board through the Imperial Institute of Entomology.

Although a froghopper parasite was the primary objective, the natural enemies of other West Indian cane-pests were naturally investigated when opportunity offered.

No considerable infestations by the small moth-borers (*Diatraea* spp.) were found in the vicinity of Pará, nor on the Rio Mojú, nor on the great island of Marajó, where savannah associations were studied and a very interesting savannah froghopper was investigated.

At Santarem, about half-way between Pará and Manáos, the great beds of floating grasses, both fringing the banks and travelling as free islands, apparently reached their maximum development. They consisted, and in some cases entirely, of two species, *Paspalum repens* and *Echinochloa polystachya* (*Panicum spectabile* of Le Cointe and the older writers on the Amazon) both of which occur in British Guiana cane-lands, the former very abundantly, the latter in restricted and scattered associations. These grasses, however, under Amazon conditions, reached a stature and a luxuriance unknown further north. The Amazon is the largest river in the world, and shelters the largest fresh-water fish (*Sudis gigas*), many of its other productions being on a similarly giant scale. In these floating and riparian beds of grasses nearly as stout and tall as sugar-cane itself, was found a considerable infestation of *Diatraea saccharalis*, the commonest and most destructive of all the small moth-borers. Dissection showed these borers to be attacked by a new Tachinid fly parasite, differing markedly from any hitherto studied. This parasite was reared to an extremely curious fly, with immense antennae. Specimens were submitted by the Imperial Institute of Entomology to Dr. J. M. Aldrich, a world-authority on these flies, and he was about to describe them as *Amazonella myersi*, new genus and new species, when it was discovered that Dr. C. H. T. Townsend, working independently in South Brazil, had named the same fly in 1926, as *Metagonistylum minense*, from specimens captured in Minas Geraes and the Bolivian Chaco. This name it must therefore bear, but efforts have been made to popularise the English title of Amazon fly, for it was thought that while *Amazonella* might have become as well-known as *Lixophaga*, *Metagonistylum* was too cumbrous a term to find favour among planters and other practical men who would be dealing with the fly were it introduced into British Guiana.

As regards the systematic position and relationships of the parasite, Dr. Townsend places it in the Germariinae Larvaevoridae (*in litt.*, 20th October, 1933), which is a tribe of the Echinomyiinae, of the older classification. With the flies of this group it certainly agrees in reproductive habits. Dr. Aldrich, on the other hand, regards it as a Cylindromyiine Phasiid, related to *Penthosia*.

The writer continued his journey, and in the meantime a Brazilian writer published a short account (Monte, 1933) of the Amazon fly, under Townsend's name, announcing his discovery that it parasitised the cane-borer (*Diatraea saccharalis*) in South Brazil. (See list of references at the close of this article.)

3.—Primitive ecological status.

The relation of cane-areas to grass-areas in the Lower Amazon, the home of the Amazon fly, is a curious one to those accustomed to cane-field conditions. While there are literally hundreds of square miles of water-grass flats, fringing all the river channels and filling completely many interior passages (*paranás* and *igarapés*) and whole chains of large lagoons, the areas under cane, mostly peasant provision-patches, are insignificant and scattered. I have elsewhere drawn attention to the greater frequency of pests under extensive estate cultivation as compared with peasant crop conditions. This is especially marked in the case of the borers (*Diatraea* spp.), but here on the Amazon the grass-associations take the place of estates, for the *Diatraea* infestation was much greater in the wild grass-beds than in the cane-patches.

The percentage of parasitism varied tremendously from place to place, even if we exclude entirely all collecting localities where, in the course of exploration, we found only odd specimens. In beds of perimenbéca (*Paspalum repens*), of varying size but which grew as far as we could gather, under precisely similar conditions,

from which we obtained the vast majority of our collections, the rate of parasitism varied from 10 to 40 per cent. The greatest single factor definitely correlated with variation in the abundance of Amazon fly, was the relative number present of another fly parasite of *Diatraea*, namely *Stomatodexia diadema*. Whether the influence of *Stomatodexia* was a matter of direct competition, or on the other hand, could be explained by ecological factors in one place favouring *Metagonistylum* and in another, *Stomatodexia*, we could not ascertain. In only one case were larvae of *Stomatodexia* and of *Metagonistylum*. encountered in one host larva. This was in an association where the rate of parasitism of *Stomatodexia* was 16.5 per cent., that of *Microdus*, 12 per cent., and that of *Metagonistylum* only 0.5 per cent. The Amazon fly larva was dead, while the *Stomatodexia*, was alive and healthy. Both were about half-grown and of similar size. *Stomatodexia* larvae often infest very young *Diatraea* larvae when they first leave the grass-blades and burrow into the shoot. *Metagonistylum* was never found in such young larvae. Whichever way the influence works, however, it may be taken as a happy augury for the success of *Metagonistylum* in British Guiana, that *Stomatodexia* is there very local and rare. A few numerical examples of collected puparia showing this extraordinarily marked correlation may be given as follows:—

Diatraea population.	*Metagonistylum.*	*Stomatodexia.*
A	10	3
B	13	3
C	19	3
D	18	2
E	39	3
F	18	1
G	1	17
H	4	17
I	13	33
J	5	22
K	24	0
L	29	0
M	30	0

Naturally we soon learned to look on *Stomatodexia* as a negative indicator for the Amazon fly and we tended more and more to concentrate on grass-beds where *Stomatodexia* was practically absent. Consequently the higher concentrations of the latter fly received very much less study. It is a curious fact that in the very intensive investigations carried out in British Guiana in 1929, *Stomatodexia* was never found in wild grass-hosts.*

* In view of its high rate of parasitism in certain associations, *Stomatodexia* was seriously considered for subsidiary introduction into British Guiana. It was thought that it might prove a different biological race from that already in Demerara, for such things are well-known in Tachinidae. But the possibility, if not probability, on the above evidence, of direct competition, decided me against it, at least until the effect of the Amazon fly introduction has been ascertained.

Two other factors influence the status of the Amazon fly in its native home. One is the rare presence of hyperparasites, three species of which, a small slender Pteromalid, a rather larger and stouter Encyrtid and a small beetle-like Encyrtid, were sent to the Imperial Institute of Entomology for identification. All three of these emerged, in some numbers, from the Amazon fly puparia, the third species being the most abundant. Some idea of their relative infrequency may be derived from the fact that during the collection and rearing of some 3,000 puparia of *Metagonistylum*, only six cases of hyperparasitism were encountered. This does not, however, present a true picture, since practically all the hyperparasites occurred in residual host-populations, at the end of infestations in drying grass-beds. Very few hyperparasites were found in the younger stages of infestations, which gave us the bulk of our material. Needless to say, the Amazon fly has been established in British Guiana without these natural enemies. One of them, however, namely, the small black beetle-like Encyrtid, attacks also *Stomatodexia* on the Amazon, and may therefore occur already in British Guiana, associated with that host.

The other factor possibly influencing to some extent the status of *Metagonistylum*, is the competition between it and two other main parasites of *Diatraea* on the Amazon. The first is the fly, *Paratheresia claripalpis*, also present as a rare insect in some Demerara cane-fields. The influence of this must be practically nil, since this species shows totally different ecological requirements, so that the habitats of the two species practically never overlap. *Paratheresia* is closely restricted to borers in drier grass-associations (*Paspalum virgatum* and *P. fasciculatum*) and was only once found in the water-grass beds so beloved of *Metagonistylum*.

The other common parasite of *Diatraea* on the Amazon is the Braconid, *Microdus stigmaterus*. Here there was no sign of the close relation existing between the number of *Stomatodexia* and that of the Amazon fly. There was, however, some considerable evidence that *Microdus* and *Metagonistylum* prefer the same habitat; and there was a slight indication of actual competition between them. In one case a *Diatraea saccharalis* caterpillar contained an apparently full-fed *Metagonistylum* larva, and a *Microdus* larva nearly as much developed. The next day the *Microdus* larva was dead and the fly maggot had successfully pupated. In a second case, an Amazon fly larva and a *Microdus* larva, both full-fed, were found in the otherwise practically empty skin of a borer (*Diatraea*) whose substance they had destroyed between them. Next morning the Tachinid had pupated normally, while the *Microdus* was dead. Such advantage as there is, would appear, therefore, to be on the side of the Tachinid. *Microdus* is present abundantly in British Guiana in grasses, but as a check on borers in cane it is usually practically negligible. No fears need be entertained, therefore, of deleterious competition between the two species in the Guiana cane-fields.

The vegetational characteristics of Amazon fly habitats will be considered in some detail in a botanical paper. It should be mentioned here that next to the beds of actually floating *Paspalum repens*, the zone of canna-rana (*Echinochloa polystachya*) yielded the most puparia. This larger and stouter grass forms the next zone shoreward of the *Paspalum* beds, and grows in shallower water or on the actual bank. At the time we were making our collections, namely in the advancing dry season, the water-level was falling with some rapidity, and tending to leave the grass-beds, particularly the shoreward canna-rana high and dry. Canna-rana was able to continue its growth to some extent under these conditions, but *Paspalum repens* promptly withered up. There always remained, however, extensive floating beds in which collecting was as profitable as ever. In the dried areas of *Paspalum repens* the *Diatraea* population was destroyed, and with it the parasites. There seemed, however, to be no valid reason why the infestation should not continue in the canna-rana stands which remained more or less flourishing on dry land, but in actual practice we found only residual populations of hosts and parasites, vast numbers of pupal exuviae of *Diatraea* and *Metagonistylum*, and empty cocoons of *Microdus*, while the few *Metagonistylum* which remained whole, were heavily hyperparasitised, and were thus not worth collecting. An analysis of this situation, important in view of the desirability of *Metagonistylum* colonising cane-fields, showed that though the canna-rana remained alive, conditions were far from favourable for such an aquatic species, and the appearance of young shoots, which are the favourite points of *Diatraea* attack, ceased almost entirely, while the older stems, albeit still growing, became very hard and woody. In the case of cane, of course, the production of suitable young shoots continues throughout the life of the crop, while the older stems remain juicy and attractive to *Diatraea*.

4.—Biology of the Amazon fly.

To Mr. L. C. Scaramuzza, my very able assistant in the Amazon fly work, as before in the *Lixophaga* campaign in Cuba, is due the credit of having first elucidated the main facts of the life-history and methods of reproduction of *Metagonistylum*. Mr. L. D. Cleare, who was responsible for the very efficient breeding and speedy establishment of the parasites sent to British Guiana, extended this study very considerably, and it is to these two workers that we owe most of our knowledge of the biology of the Amazon fly.

Reproduction.—The Amazon fly deposits 500 to 700 young and extremely active larvae near the entrance to the borer tunnels. Thence these minute maggots crawl into the borer and, piercing its skin, take up a position inside it. There they develop and eventually kill the host, leaving the empty skin and pupating within the burrow. In the field two healthy larvae were frequently reared from a single *Diatraea*, three were not infrequent, and three cases of four were found. Mr. Cleare, in the laboratory, saw one instance of seven from one host. The adult flies in these cases are usually smaller. The larva of *Metagonistylum* differs from all the other Dipterous parasites of *Diatraea* in the presence of conspicuous rows of black bristles on practically every segment. These occur in *Lixophaga* only on two or three segments, while in *Paratheresia* and *Stomatodexia* they are entirely absent. Compared with the last two, the *Metagonistylum* larva is much more strongly built and vigorous. Ordinarily the larva kills the host-caterpillar when it is full-fed, and has already begun to cut the side-entrance which would later be used for the exit of the adult moth, but which instead affords the normal means of egress of the fly. In one case a larva emerged from a *Diatraea* prepupa.

According to the careful rearing-records of Mr. Cleare, under laboratory conditions in British Guiana the length of the pupal stage is about eight days, while the period from larviposition to the emergence of the fly covers 14 days. Mating takes place only a few hours after emergence and the succeeding period of gestation varied, under the above conditions and with the same observer, from six to seven days. This agrees very well with the results obtained on the Amazon where however, the pupal period was a trifle longer—8½ to 9 days.

The favourite host of the Amazon fly is undoubtedly the common borer (*Diatraea saccharalis*). The bulk of the material studied on the Amazon came from this host-species. The parasite also attacked, in considerable numbers, in sugar-cane, another *Diatraea*, apparently a new species, allied to *Diatraea impersonatella*, the most destructive small borer in Trinidad. It was never found to parasitise the yellow-headed borer (*Diatraea canella*), and tests by Mr. Cleare in Georgetown showed that it was only very infrequently induced to attack this species. An effective specific parasite of *Diatraea canella* is thus a great desideratum, not only for British Guiana but also for Trinidad and the islands up to and including St. Lucia.

5.—Introduction into British Guiana.

Ecological considerations.—The older successes of biological control were in most cases gained by the introduction of parasites into countries where they did not occur, to attack introduced pests. The introduction of *Metagonistylum* into British Guiana might seem, at first sight, to run entirely counter to the above empirical principles (since the parasite occurs in the same land-mass while the pest is an indigenous insect), and it must therefore be justified ecologically. I have stressed, however, in previous publications (1928, 1931) the importance, in this connection, of substituting an ecological conception for a geographical one. In other words, it is the ecological isolation of the given area which counts far more than its geographical limits, and I have elsewhere shown (1931) that the cane-lands of

British Guiana form an extremely isolated and restricted ecological island. Actually the first spectacular success of biological control consisted in the introduction of a ladybird (*Novius cardinalis*), into an ecological island—California.

The second point of divergence, the fact that *Diatraea* is, so far as the evidence goes, indigenous in British Guiana, may be shown to be of no importance ecologically, since the pest has lost its original status of a somewhat infrequent inhabitant of wild grasses, where it is controlled up to 70 per cent. by parasites (Myers, 1931), and has invaded an induced association of introduced sugar-cane, to which, save in entirely negligible proportions, its parasites have been unable to follow it. There is surely no valid ecological or practical difference between a pest introduced into a new country without its parasites, and an indigenous insect which, in a circumscribed biological or geographical island has learned to live upon a cultivated crop, while its parasites, although perhaps already abundant in the area, have not yet become adapted to attacking it in its new host-plant. That the difference *is* invalid, is shown by the successful control in Fiji of an apparently indigenous insect, by the utilisation of a parasite attacking elsewhere a species not even closely related to the pest in question, the coconut moth (*Levuana iridescens*).

The suggested introduction of the Amazon fly into British Guiana was thus not contra-indicated by any ecological or empirical considerations. Accordingly, when the writer arrived in Georgetown in January, 1933, informed the Director of Agriculture and the Sugar Producer's Association of the discovery of a new borer-parasite, and suggested its utilisation, the latter body promptly voted the sum of £2,000 for the expenses of an introduction campaign. The fund was administered by the Director of Agriculture and thus the essentially close co-operation with the local agricultural authorities and with the special *Diatraea* entomologist, Mr. L. D. Cleare, was ensured.

6.—Collection of Material.

Means of transport on the Amazon near Santarem are confined almost entirely to water. Practically the whole of the material shipped, or from which further supplies were reared in the laboratory, was collected from boats and canoes. It was necessary, at the height of the campaign to employ a small fleet consisting of a motor-launch, in addition to that carrying the shipments to Pará, a small sailing-boat, and 11 dug-out canoes or montarias. Some of the richest collecting-grounds lay ten miles and more from the laboratory, and the frequent heavy seas at that season, in stretches of open water three or four miles across, made travelling uncomfortable and at times dangerous.

The collecting personnel, save for three Arawak and coloured men from British Guiana, who acted as foremen, was entirely recruited locally, and reached a total at times of 40 people. This labour, of mixed aboriginal, African and white blood, proved extremely intelligent, trainable and hardworking, often labouring from 5 a.m. till 7 or 8 p.m., with great cheerfulness and without overtime pay. As a rule whole families, with their own canoes, the hire of which was included in the daily wage, were recruited near the collecting-grounds, the men and boys bringing in the infested grasses, the girls and young women dissecting these out and the older women cooking the food for the party.

The day's collections of puparia were kept on damp, sterilised, sifted bagasse in an ice-box, until shipment. The *Diatraea* larvae, on the other hand, had each to be placed in a separate small ointment-tin*, with food, and reared till it either produced a parasite or pupated.

7.—Transport to British Guiana.

Transport was the most expensive and difficult part of the campaign. The Panair do Brasil (an affiliation of Pan-American Airways) supplied a weekly service from Pará to Georgetown, making the journey in one day. The problem lay in covering regularly, and as frequently as possible the stretch of some 470 miles of river between the collecting base at Santarem and the air-port at Pará. The river steamers, of which there are many, were too infrequent or too irregular; for example one on which I travelled from Manáos was no less than a week late, and this belonged to one of the largest and most dependable companies. The time at our disposal was insufficient for such delays. The parasites were sent as puparia, the normal period of pupation being about nine days, which could be extended to a maximum of 13 by a judicious use of ice. Thus with freshly-reared puparia we had available a maximum of 13 days, and with collected puparia of unknown age a correspondingly shorter period. It was almost a physical impossibility save by plane to Pará to make a shipment by every plane, since besides the time spent in the journey, a day was invariably necessary for the posting formalities in Pará.

Preliminary enquiries having shown that the cost of a chartered aeroplane was prohibitive, a 26-ft. launch† was bought in Glasgow, of a type

* Occasionally the full-fed parasite larvae emerged from the food-material and pupated in the tin. In such cases it frequently happened, especially in the angle between the sides and the bottom, that the puparium stuck so firmly that it could not be removed without injury. The side in contact with the tin remained soft, white and supple larval integument, with no puparial hardening nor darkening. It would appear that the presence of rust disturbed the oxidation process of puparial hardening. I have never had this happen with other Tachinids, nor with these save in rusty tins. The trouble could be obviated by painting the inside of the tins with paraffin wax, as Mr. Cleare was accustomed to do in Georgetown.

† The voyage of this launch from Georgetown up the Essequebo, its wreck in the rapids, and eventual salvaging, its crossing of the watershed into the Rio Mahu, and its passage to Santarem *via* the Rio Branco, Rio Negro and Manáos, form another story which need not be told here.

likely to withstand the heavy seas of the lower Amazon, with a stretch of some 50 miles of open water approaching Pará. This launch proved eminently suitable for the work, and made, without mishap and with clockwork regularity, the journey to Pará and back every fortnight. This, however, was rendered possible only by the courage and devotion of my engineer-captain, Senhor José Paes, to whom a large part of the success of the campaign is due. The notion of travelling to Pará in such a small boat was received locally with amusement and then stigmatised as suicidal. Towards the end of the very first journey the pilot declared that to go on through the high seas was impossible and they must turn back. Only the firm determination of Paes forced him on, and thereafter it became a matter of pride on the part of both men to maintain a regular service, to the astonishment of the whole population of the lower Amazon.

By this means, a shipment of puparia packed in Santarem on Thursday night reached Georgetown on the Tuesday night. But it meant that the captain and pilot had no sleep during the whole journey, in the course of which they were wet through most of the time from waves which broke over the bow.

When the work was drawing to a close, an aeroplane service was inaugurated between Pará and Manáos, stopping at Santarem. Unfortunately it connected with the south-bound plane but not with the north one. The plane left Santarem on Friday morning (thus some 10 hours later than our launch) and reached Pará the same day, but the package of parasites, having been necessarily posted in Santarem, had to lie in the Pará post-office for three days without ice, whereas in the launch it was kept on ice till the day before the plane left. The sixth shipment sent by this means, arrived, as a result, in inferior condition, the launch service proving thus much more efficient though much more costly, in spite of the fact that the parasites sent by plane had to pay letter-post.

As in the *Lixophaga* campaign in Cuba, the Pan-American Airways' officials were invariably exceedingly courteous and obliging.

8.—Establishment by Mr. L. D. Cleare.

The parasite-puparia were received in Georgetown by Mr. L. D. Cleare, Entomologist seconded from the Department of Agriculture for special moth-borer (*Diatraea*) investigations. Mr. Scaramuzza had previously ascertained in the field that the Amazon fly was amenable to the same technique which he had invented for the mass-rearing of the Cuba fly (*Lixophaga*) and which, in the hands of Mr. Box, was largely responsible for the speedy establishment of that fly in the Leeward Islands. This technique consisted in the dissection of the uterus from a gravid female, the loosening of the young larvae and their careful placing on a host-caterpillar. The success of the method, elaborated and extended by Mr. Cleare, was even more marked than in the case of *Lixophaga*. Large numbers of flies were reared, many liberations were made, and by the middle of March, 1934, only 6½ months after the first trial shipment was despatched from the Amazon, it had been recovered in some numbers on six different estates in Demerara and Berbice. It was recommended that rearing and liberation should be kept up for another year, and several of the estates took up this work enthusiastically, with the help of East Indian youths trained by Mr. Cleare, and under his advisory supervision.

9.—Acknowledgments.

I am indebted above all to the devotion and hard work of my two assistants, Mr. A. Pickles and Mr. L. C. Scaramuzza. The former, although working only on the froghopper investigation, under the Trinidad Sugar Cane Investigation Committee, was of invaluable assistance to the expedition as a whole. The two junior assistants from British Guiana, Harold Spence and Clarence Smith, became most efficient field-workers, and were soon enabled by their rapid progress in the Portuguese language, to act as foremen in the Brazilian labour force. I have already mentioned the personnel of the launch.

The municipal authorities at Santarem facilitated the work in every possible way, while federal authorisation and much other help was secured through His Majesty's Ambassador in Rio de Janeiro, Consul in Pará, and Vice-Consul in Manáos.

To Professor J. S. Dash, Director of Agriculture, British Guiana, and to several of his officers, I am indebted for every facility in that Colony, and for enthusiastic co-operation. Establishment of the fly in British Guiana was secured by the high technical skill and untiring industry of Mr. L. D. Cleare.

The authorities at the Ford Concession on the Rio Tapajoz, especially Mr. Rogge, then local manager, and Dr. Needles, in charge of the hospital, were most kind in supplying us with laboratory apparatus and lending us a binocular microscope, to take the place of those lost in the rapids.

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OBSERVATIONS ON THE STORAGE OF VARIOUS FRUITS AND VEGETABLES.

I.—Tomatoes, Cauliflowers, String Beans, Egg-Plant, Cucumbers, and Muskmelons.

By C. W. Wardlaw, E. R. Leonard and R. E. D. Baker.
(*Imperial College of Tropical Agriculture.*)

Following on the recommendations of the recent Jamaica Fruit and Vegetable Conference (1) and in continuation of studies already initiated at the College Low Temperature Station, experimental observations have been made to determine the storage behaviour and requirements of a number of different commodities with a view to fostering possible export industries. In some instances, *e.g.*, tomatoes, where storage experiments had already been carried out the records are of a supplementary character, but in others the work undertaken breaks new ground and the results should accordingly be regarded as preliminary in nature.

TOMATOES.

Following on previous storage trials with tropically-grown tomatoes (2, 3) further experiments have been carried out to determine the effect of cultural conditions and date of picking on the storage qualities of the fruit. The same variety as before—Bonnie Best—was used from plots on the College farm and similar experimental methods employed in the storage trials.

The entire experimental area was treated with a dressing of farmyard manure at the rate of three tons per acre applied at time of sowing. Individual plots then received in addition two, or in the control series, all three of the following: sulphate of ammonia, sulphate of potash, superphosphate, in the proportion of 4 : 5 : 11, the NPK plots receiving the mixture at the rate of 14 cwt. per acre and the PK, NP, and NK, plots their respective manures in the above proportion. A top dressing of one-third the above rates was applied at a later date.

Storage Trials.

Five consignments of fruit were taken at approximately equal intervals from the several manurial treatments on Jan. 29th, Feb. 11th and 19th, March 1st and 8th (consignments I-V). The fruits were graded as "full-grown but green" and "just turning" and ranged from about 2 ins. to 2¾ ins. in diameter. About 100 fruits from each treatment were taken and separated into two portions of 40 or 50 each except in consignment II when only smaller numbers were available. One portion was stored at 45°F. and the other at 50°F. for 20 days and then transferred to 70°F. to ripen. A very high degree of culling was required in the selection of all consignments, some two-thirds of each picking being rejected on the grounds of damage, over-ripeness, small size or malformation. Counts were made of the green, turning, ripe and waste fruit at the time of transference to 70°F. and after five and seven days at this temperature.

Rate of Ripening.

This can be assessed as the rate of decrease in number of green fruits or increase in total number of ripe fruit, *i.e.*, ripe *plus* wastage, but owing to the possibility of fruit classed as "green" in different consignments being at different stages of maturity, the small number of fruit involved and the absence of any replication, only general impressions can be put forward to indicate the effect of the different factors on the rate of ripening.

Seasonal Effect on Rate of Ripening.

The general trend in all manurial treatments was found to be a decrease in rate of ripening between the first and second consignments followed by an increase during the last three. This trend is especially marked in fruit from all manurings stored at 50°F., and in NP and NK at 45°F. PK shows a slight increase in rate of ripening through the season when stored at the latter temperature and NPK a slight decrease through the season.

Manurial Effect on Rate of Ripening.

As estimated by various criteria—loss of greenness, increase in ripeness or total ripe fruit after five days at the ripening temperature—no consistent manurial effect on ripening rate could be observed. Since, however, from a statistical analysis of yield data no consistent effect of manures could be ascertained and since the tomatoes for the storage trials were random samples from all plots receiving any one treatment this is not surprising. The indication is, rather, that extremes of unbalanced nutrition were not reached in any instance and that within the experimental limits of manuring the storage life was unaffected.

Temperature Effect on Rate of Ripening.

Table I gives the total ripe fruit (ripe *plus* wastage) as a percentage of the whole consignment after five days at 70°F. following storage at the two temperatures and shows a consistently higher rate of ripening after storage at 50°F. except in the case of consignment II where inadequate numbers were involved.

Table I.

PER CENT. TOTAL RIPE FRUIT AFTER 5 DAYS AT 70°F.

Manurial Treatment.	Storage Treatment.	Consignment.				
		I	II	III	IV	V
NPK ..	45°F.	36	92	68	78	48
	50°F.	72	100	86	80	67
PK ..	45°F.	26	74	78	58	63
	50°F.	52	100	84	80	75
NP ..	45°F.	44	91	71	72	45
	50°F.	68	91	93	82	73
NK ..	45°F.	60	82	76	54	35
	50°F.	80	74	88	74	67

Wastage.

The high percentages of fungal wastage recorded in the corresponding storage trials of 1933 (3) were not obtained in any sample of fruit during the current investigation. The average wastage over a total storage period of 27 days was approximately ten per cent.

Seasonal Effect on Wastage.

Maximum wastage occurred in consignments III and IV as shown in Table II.

Table II.

Manurial Treatment.	Storage Treatment	Wastage per cent. Total Ripe Fruit (Ripe *plus* Wastage) after 7 days at 70°F.					
		I	II	III	IV	V	Mean.
			(4 days at 70°F.)				
NPK	45°F.	5	0	9	19	11	9 } 9
	50°F.	6	0	14	11	12	9
PK	45°F.	7.5	18	2	2.3	11	8 } 7.8
	50°F.	11.5	0	10	8.7	8	7.6
NP	45°F.	17	10	18	11	3	12 } 11
	50°F.	12	0	14	18	7	10
NK	45°F.	3	11	12	13.6	3	8.5 } 8.25
	50°F.	0	11	7	11.6	11	8
	Mean	7.5	6.25	11	12	8	

Manurial Effect on Wastage.

Here the same remarks apply as in the consideration of the effect of manuring on rate of ripening, namely that within the experimental limits of manuring, the amount of wastage is apparently unaffected.

Temperature Effect on Wastage.

Whereas previous experiments had shown the advantage of the lower temperature (45°F.) in checking fungal wastage, no clear effect of temperature on wastage was found in the present investigation.

As regards the nature of the wastage this, as previously, was due almost exclusively to *Phoma destructiva* Plowr.; thus, for example, in consignment I out of 59 infected fruit 54 were attacked by *P. destructiva* with or without secondary fungi.

Figs. 1 and 2 show the rates of ripening of NP fruit from the five consignments at 70°F. after the usual storage period at the two temperatures and also the wastage rates for the same fruit. From these and similar diagrams for the other manurings Table III was constructed to show the time in days at 70°F. before the 10 per cent. commercial limit of wastage is reached and also the total percentage of fruit which has ripened by this time. In the case of manurial treatments and consignments not tabulated, this 10 per cent. limit was not reached by the 7th day at 70°F. or the fruit reached 100 per cent. ripe without this amount of wastage.

Table III.

Manurial Treatment.	Storage Treatment.	Consignment.	Days at 70°F.	Per cent. Total Ripe Fruit.
NPK ..	45°F.	IV	5½	79
	50°F.	III	6	93
	50°F.	IV	7	92
	50°F.	V	6½	98
PK ..	45°F.	II	3	60
	45°F.	IV	9	96
	50°F.	III	5	84
	50°F.	IV	7½	93
NP ..	45°F.	I	6½	64
	45°F.	III	3	63
	45°F.	IV	5	72
	50°F.	I	6	85
	50°F.	III	6	97
	50°F.	IV	5	82
NK ..	45°F.	III	6½	94
	45°F.	IV	6	68
	50°F.	IV	7	86
	50°F.	V	7	88

From this table it appears that with the great majority of manurial treatments in all consignments, at both temperatures, a period of at least five days is available for distribution after the fruit leaves cold storage and before 10 per cent. wastage occurs.

Tomato Variety Experiments.

A single storage trial with three varieties of tomato—Bonnie Best, Red Rock and Marglobe—was also undertaken using fruit from another experimental plot on the College Farm. This was treated and stored in the same way as was the fruit in the manurial experiment. Again owing to the inadequate supply of fruit available only general impressions can be given. These are that (1) Bonnie Best showed the highest ripening rate, with the other two varieties approximately equal.

FIG. 1.

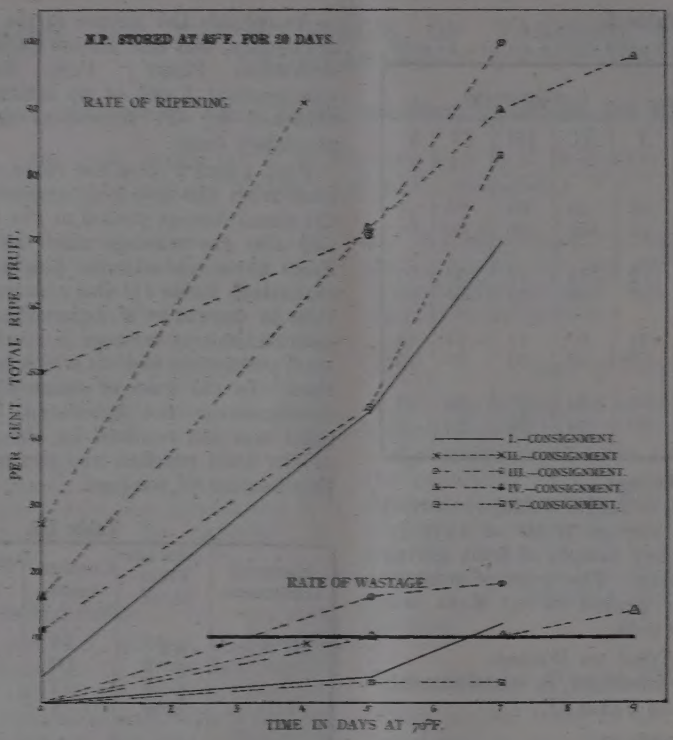
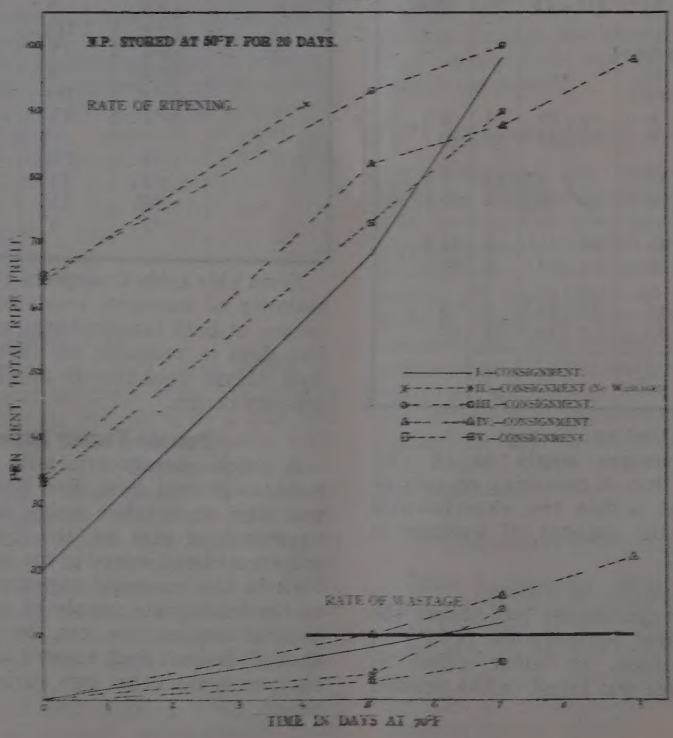

N.P. STORED AT 45°F. FOR 20 DAYS.
RATE OF RIPENING.
RATE OF WASTAGE.
PER CENT TOTAL RIPE FRUIT.
TIME IN DAYS AT 70°F.
I.—CONSIGNMENT.
II.—CONSIGNMENT
III.—CONSIGNMENT.
IV.—CONSIGNMENT.
V.—CONSIGNMENT.

FIG. 2.


N.P. STORED AT 50°F. FOR 20 DAYS.
RATE OF RIPENING.
RATE OF WASTAGE.
PER CENT TOTAL RIPE FRUIT.
TIME IN DAYS AT 70°F
I.—CONSIGNMENT.
II.—CONSIGNMENT
III.—CONSIGNMENT.
IV.—CONSIGNMENT.
V.—CONSIGNMENT.

(2) No wastage whatever occurred during the cold storage period at either temperature.

(3) Wastage was highest in Bonnie Best, with the other two varieties approximately equal, the time for the former variety to reach the 10 per cent. wastage limit at the ripening temperature being five to six days with 58 per cent. and 72 per cent. fruit ripe after storage at 45°F. and 50°F. respectively; whereas Red Rock and Marglobe after nine days ripening showed 92 per cent. and 96 per cent., 84 per cent. and 96 per cent. ripe at the two temperatures.

Prolonged Cold Storage.

A small consignment of Bonnie Best tomatoes from the College Farm manurial plot, picked green or turning, was held at 45°F. for a total of 41 days during which ripening took place slowly so that 65 per cent. had ripened with only two per cent. wastage. The acid flavour, however, was lost in these fruits by about the 35th day and they had become somewhat shrivelled. On transference to 70°F. the remaining green fruit ripened after eight days.

The Effect of Environment.

Tomatoes of the variety Marglobe were obtained from the Débé dry lagoon and stored at 45°F. for 21 days. Their storage behaviour was similar to that of the College Farm fruit and the whole consignment ripened after seven days at 70°F.

Summary.

1. Storage trials on tomatoes grown under various manurial treatments have shown that no marked effect on the storage life is apparent within fairly wide limits of manuring provided the fruit is picked green and free from damage.

2. During a cropping period of five to six weeks the nature of the fruit is not sufficiently altered to affect its keeping qualities.

3. Wastage is primarily due to *P. destructiva* Plowr.: it is kept in check at the two temperatures employed, only becoming apparent when fruit is ripening.

4. A storage life of 20 days at 45°F. or 50°F. followed by ripening for five days at 70°F. was consistently obtained before serious fungal wastage occurred.

References.

(1) West Indian and Inter-Colonial Fruit and Vegetable Conference, Jamaica, 1933. Report, Recommendations and Proceedings. Govt. Printing Office, Jamaica.

(2) Empire Marketing Board Report No. 59, 1932

(3) *Tropical Agriculture* Vol. X, No. 6, 1933.

* * *

CAULIFLOWERS.

Cauliflowers of intermediate size, grown on the College Farm from Patna seed, were held at 45°F. for 15 days and then transferred to 70°F. On removal from cold storage there was some shrivelling of the outer leaves, but the head was in good condition. After three days at the higher temperature the outer leaves had all dropped as a result of desiccation; the head, however, was still in fair condition and the flavour after cooking was quite good.

Two later consignments were successfully held at 45°F. for 20 days followed by three days at 70°F. Desiccation causing dropping of the leaves was again the chief source of depreciation. After two to three days at 70°F. a dark brown spotting distributed over the head, followed by outgrowths of the hyphae of *Alternaria brassicae* (Berk.) Sacc. became evident in some of the samples.

STRING BEANS.

String beans (Henderson's Bountiful), packed in a standard 20 lb. crate, held at 45°F. for 22 days (with subsequent transference to 70°F.) were found to possess good keeping qualities at this temperature provided excessive desiccation could be avoided.

Small lots of 100 grammes, wrapped in grease-proof* paper, were exposed at 80°F. (approx.), 60°F., 50°F. and 45°F. with the results shown in Table IV. Further losses on transference to 70°F. are indicated on the right-hand side.

Table IV.

Temperature Deg. F.	Relative Humidity per cent.	Loss in weight after			Total percentage loss in weight on transference to 70°F	
		14 days	20 days	22 days	2 days	4 days
45°F.	80–85	25	35	39	46	52
50°F.	80	27	41	43	51	57
60°F.	75–80	38	35	—	—	—
80°F.	55–95	78	91	—	—	—

The exposure of small lots results in a loss in weight greatly in excess of that which would normally be experienced in closely packed crates. While such a vegetable can lose a considerable proportion of its original moisture content before it becomes noticeably dry to the taste, nevertheless in packing and bulk storage, provision should be made to avoid excessive desiccation.

There was no fungal wastage.

EGG-PLANT (*Solanum melongena*).

Egg-plants from the College Farm of two types—long narrow and short round—were stored at 45°F. Considerable losses in weight occurred as shown in Table V producing slight shrivelling of the fruit, and small patches of grey mycelium were formed on the skin and calyx in the course of 32 days

*It should be noted that wrapping in grease-proof paper achieves little or nothing in the conservation of moisture.

storage. At 45°F. internal browning occurred in some of the round fruit but on cooking fruit still white after storage at either temperature for this period the flavour was found to be quite good.

Table V.

Temp. Deg. F.	Relative Humidity.	Type.	Per cent. loss in weight after		
			10 days	20 days	32 days
45°F	86-85%	Long	6.9	12.6	17.4
		Round	6.0	13.2	20.3
50°F	80 %	Long	8.3	14.1	19.7
		Round	8.2	14.7	22.0

CUCUMBERS.

Cucumbers, of small, intermediate and large size, grown on the College Farm, were stored at 45°F., 50°F. and 60°F. for periods up to 40 days.

No difficulty was experienced in holding this commodity in excellent condition for 20 to 25 days at the lower temperatures, 50°F. being more favourable than 45°F. After 25 to 30 days the fruits, especially the larger ones, began to show yellowing, accompanied by the production of a bitter flavour. At this stage various storage pathogens became evident, causing stem-end rots and superficially distributed sunken spots and soft-rots, as a result of which the fruits finally collapsed into a mass of malodorous leaking tissue.

In the course of 22 days, fruits held at 45°F. lost 10 to 13 per cent. of their original weight, and fruits at 50°F. 11 to 15 per cent., a relative humidity of 80 to 85 per cent. being maintained in the storage rooms.

Wastage.

After the thirtieth day wastage was much in evidence at the several temperatures. The pathogenic organisms observed have already been described in the literature. The following were responsible for the more serious aspects of rotting observed.

Colletotrichum lagenarium (Pass.) E. and H. (*Gloeosporium lagenarum* (Pass.) Sacc. and Roum.) this organism causes circular or irregular depressed areas over the fruit surface; acervuli, at first salmon-coloured but later becoming darker, develop on the surface of the spots; conidia 15-20 × 5-6 μ, setae 40-80 × 4 μ; these infections are followed by secondary soft-rotting organisms, resulting finally in collapse of the fruit.

Fusarium spp., including *F. succisae* (Schroet.) Sacc., are responsible for a soft-rotting of the stem-end, which gradually encroaches on the fruit, liquefying the flesh; round the base of the fruit superficial mycelium and sporodochia may be observed.

Other species of *Fusarium* are responsible or partly responsible for the development of sunken blemishes distributed over the fruit.

Mycosphaerella citrullina (Sm.) Gross. (*Ascochyta citrullina* (Chester) Sm.: *Diplodia citrullina* (Sm.) Gross.); this fungus is responsible for a characteristic conspicuous black-rotting of cucumbers, infections occurring either at the stem-end or distributed over the surface; early stages of infection consist of greyish water-soaked areas; these gradually spread—one-third of the fruit being sometimes affected—darken and become wrinkled or involuted as a result of the penetration of secondary fungi into the underlying tissues; the blackened surface becomes encrusted with pycnidia and perithecia, from which characteristic one-septate, slightly constricted conidia and ascospores are later extruded.

Cladosporium cucumerinum Ell. and Arth.; this organism was chiefly in evidence on fruits held for 30 to 40 days at 45°F.; elsewhere it has been described as responsible for scab disease of cucumbers, muskmelons, &c.; the fungus develops on small, sunken, sometimes coalescing lesions, forming dark, velvety green colonies.

Macrosporium cucumerinum E. and E.; this fungus causes a rotting of the stem-end of the fruit and also superficial spreading sunken spots which later become involuted; the green colour imparted to the lesions by the presence of *M. cucumerinum* also extends inwards into the flesh which is rendered somewhat watery; on the dark green, smoky, superficial mycelium, conidia are produced in large numbers.

Other organisms observed on the surface of diseased fruits included *Vermicularia capsici* Syd., *Isaria* sp. and other fungi.

MUSKMELONS.

Muskmelons held at 45°F. and 50°F. for 15 to 20 days were characterised by poor flavour and the development of numerous anthracnose spots (*Colletotrichum lagenarium* (Pass.) E. and H.) and various superficial soft-rots (*Fusarium* spp.) The quality of the several varieties examined was poor and so far no fruits with commercial possibilities have come to hand for storage trials.

(To be concluded.)

Survival of Cane Borers in Trash.—*W. E. Hinds.*

While this major pest of the sugar-cane may pass the winter in corn stalks, Johnson grass, or even rice stubble, its main shelter is the trash left on the cane fields at harvest. Control of the pest is therefore largely a matter of disposing of the trash in one of three ways: by drawing it into the low middles where it will be flooded and the living borer stages drowned; by turning the trash out of sight in the soil; or by burning. The latter method is to be recommended, provided the trash is sufficiently dry to get a good burn. It is not thought that burning the trash has any serious effect on the egg parasite *Trichogramma minutum*.—(*Int. Sugar Journal*, Vol. XXXVI, No. 423, 1934, pp. 119.)

A VARIETY TEST ON SUGAR-CANE.

By R. Cecil Wood, M.A., Dip. Agric. (Cantab.).

An experiment was started in 1930 to compare a number of thin canes as to their suitability for cultivation in Trinidad. The only cane of this class grown at present in the island, on any scale, is Uba, and it has accordingly been taken as the standard of comparison. At the time, it was considered that the future of cane growing in Trinidad was possibly bound up with these thin canes, for though they cannot be counted on to yield as much sugar as the Noble canes, they are hardier, and cost less to grow.

Nine canes were selected for trial: five of the P. O. J. canes, Nos. 36, 213, 234, 826 and 2878: two Coimbatore canes, 213 and 281, M. 36 and Uba. These were grown in small plots of .07 acres each, replicated four times.

The figures for the first two crops have been published in *Tropical Agriculture*, Vol. IX, 290 and Vol. X, 188. The present report deals with the second ratoon crop, and though it has been decided to continue the canes for another crop, a brief review of the complete experiment to date, may be of interest to cane growers.

Table I.

Season 1933-34.—Second ratoon crop.

Variety.	Yield of Cane.		Yield of Sugar (96°).		
	Tons per acre.	Per cent. Uba.	Tons per acre.	Per cent. Uba.	Tons of cane to ton sugar.
P.O.J. 2878 ..	36.1	153	3.79	150	9.0
Co. 213 ..	26.4	118	2.63	108	9.9
P.O.J. 36 ..	24.1	107	2.63	108	9.1
P.O.J. 213 ..	19.0	85	2.46	104	7.7
M. 36 (2 plots)	24.9	111	2.40	101	10.4
Uba ..	22.3	**100**	2.38	**100**	9.9
Co. 281 (2 plots)	19.8	88	1.30	54	15.4
P.O.J. 826 ..	13.0	58	1.51	62	8.6
P.O.J. 234 ..	16.9	75	2.01	83	8.5

Analysis of variance applied to the data showing the yield of cane, gives a calculated value of z of 1.571, as compared with .695 read from Fisher's table of z, for the probability of 1 per cent.

Table II.

Variety.	Tons *Cane* per acre.				Tons *Sugar* per acre.				Tons cane to 1 ton sugar.			
	Plant.	1st rat.	2nd rat.	**Total.**	Plant.	1st rat.	2nd rat.	**Total.**	Plant.	1st rat.	2nd rat.	**Mean.**
P.O.J. 2878 ..	63	30	34	**121**	4.87	3.06	3.79	**11.72**	12.9	9.8	9.0	**10.6**
Co. 213	57	34	26	**112**	3.80	2.82	2.63	**9.25**	15.0	12.1	9.9	**12.3**
P.O.J. 36	33	26	22	**98**	3.40	2.80	2.63	**8.83**	13.8	11.1	9.1	**11.3**
P.O.J. 213 ..	23	20	17	**79**	3.16	2.72	2.46	**8.34**	11.7	9.6	7.7	**9.7**
M. 36 (2 plots) ..	48	32	25	**100**	3.32	2.60	2.40	**8.32**	14.4	12.3	10.4	**12.3**
Uba	37	26	19	**78**	2.50	2.21	2.38	**7.09**	13.2	11.8	9.9	**11.6**
Co. 281 (2 plots) ..	47	31	24	**70**	2.75	2.33	1.30	**6.38**	10.9	9.9	15.4	**12.1**
P.O.J. 826	33	20	13	**63**	2.55	2.30	1.51	**6.36**	12.9	8.7	8.6	**10.1**
P.O.J 234	30	23	20	**58**	2.03	2.18	2.01	**6.22**	11.3	9.5	8.5	**9.8**
Mean	**41**	**27**	**22**		**3.15**	**2.56**	**2.34**		**12.9**	**10.5**	**9.8**	

This proves that the experiment is significant, and a difference between any pair of varieties greater than 19 per cent. (4.4 tons per acre) possesses real significance and cannot be ascribed to chance.

(*b*) *Sugar Yields.*—The figures for sugar in previous years were obtained from sample stools cut at random in the field and crushed in a laboratory mill. This year it was arranged that the produce of each plot should be put through the College mill, and by the courtesy of the College Sugar Technology Department, a sample was taken of the mixed juice of each plot. The figures may accordingly be taken as very much more reliable than those previously published.

The test for significance gives a calculated value of z of .986 as compared with .695, and the results are therefore clearly significant at the 1 per cent. mark, anything over 19 per cent. (.48 tons per acre) being beyond doubt.

The results of the three crops are put together above in a form which will enable conclusions to be readily drawn from them.

These may be briefly expressed as percentages of Uba, both in yield of cane and in yield of sugar.

Table III.

Variety.	Total *Cane* Produced in Three Years.		Total *Sugar* Produced in Three Years.	
	Actual Tons.	Per cent. Uba.	Actual Tons.	Per cent. Uba.
P.O.J. 2878 ..	121	155	11.72	165
Co. 213 ..	112	143	9.25	130
P.O.J. 36 ..	98	126	8.83	124
P.O.J. 213 ..	79	101	8.34	117
M. 36 (2 plots) ..	100	128	8.32	117
Uba ..	78	**100**	7.09	**100**
Co. 281 (2 plots)	70	90	6.38	90
P.O.J. 826 ..	63	81	6.36	90
P.O.J. 324 ..	58	74	6.22	88

Little comment is needed on the above figures. There is no doubt that in the conditions that obtain here, P.O.J. 2878 is easily the best of these nine canes from the grower's point of view ; it is indeed unusual to find such a marked superiority in a variety test of this kind. The next group of canes includes Co. 213 and P.O.J. 36. The latter is the richer cane, as will be seen from the comparison with Uba: their yields of cane are 143 per cent. and 126 per cent. respectively, while their sugar yields are 130 per cent. and 124 per cent. P.O.J. 36 is a clean upright thin cane, light red when young and deepening in colour as it ages, which trashes well and is, for this class of cane, easy to cut. In the mill it is reported to be fair, with rather a tough fibre. The Coimbatore cane is more trashy, tends to lodge and is not so easy to cut, but is better in the mill.

The next two canes are better than Uba, but not by a margin which places their superiority beyond doubt. M. 36 is a new cane from the Mayaguez station. It is reported bad from the milling point of view, being tough and fibrous, and is not a very good field cane. P.O.J. 213 is popularly called the 'Ginger' cane and is fair in the mill though inclined to be fibrous, and as it stands up and trashes fairly well, it is a good field cane.

Of the others nothing need be said as they are below the standard of Uba and have little to recommend them.

Some Factors influencing Decay in Florida Citrus Fruits.—*J. R. Winston.*

Florida citrus fruit is subject to decay by four major organisms of which two, blue and green mould, are common to other sections of the United States and easy to suppress, while the other two, the stem-end rots, are particularly prevalent in Florida.

Pre-harvest Factors.—1. Dead wood in the trees. This is the only known source of infection of fungi causing both forms of stem-end rot. 2. Maturity at harvest. Contrary to popular belief, fruit harvested early decays much more slowly than that harvested later. 3. Fruit sprayed with less volatile types of oil within a month of picking requires longer time in the colouring room. The extra time increases decay. 4. Excessive use of ammoniate fertilizers produces fruit which bruises and decays easily. 5. Fertilizer treatments for early and mid-crops are probably not suitable for late crops. The latter are on the tree during reduced vegetative growth. If this growth is stimulated, the green pigments in the fruit rind also take on fresh life. A re-greened fruit is very difficult to colour, and means a longer time in the colouring room and increased liability to decay. 6. Cultural practices tending to produce coarse thick-skinned fruit. This type also is difficult to colour. Contributing factors to the production of coarse fruit are said to be excessive use of complete fertilizers, of ammoniates, of irrigation, of heavy leguminous cover crops annually over a period of years. Fruit on rough lemon rootstock is particularly susceptible.

Harvesting and Post-harvest Factors.—1. Careless clipping, over-filling field boxes. 2. Neglect to use borax in the washing operation. In this connection, it is noted that a borax bath before colouring is much more effective in preventing stem-end rot than if the bath is deferred till after colouring. 3. Careless treatment in the colouring room. 4. Decay between picking and pre-cooling. —(*Imperial Agricultural Bureaux, Hort. Abs.*, Vol. III, No. 3. Ab. 374.)

OBITUARY.

Mr. H. G. MILLER.

It is with the deepest regret that we have to record the death of Henry G. Miller, a loss which has deprived agriculture, and Rothamsted in particular, of one of its most brilliant and enthusiastic devotees.

Born in Dundee in 1903, Miller received his early education at Dundee High School, and later went on to take his B.Sc. (Agric.) at Edinburgh. The following year, in 1925, he came out to the College with a Scholarship from the Empire Cotton Growing Corporation where he specialised in the administrative and practical side of cotton growing. In addition, he wrote a short article for this journal on Mole Drainage and its application to tropical conditions.

Unfortunately his health did not permit him to live in the tropics, and on his return to England he was appointed farm manager to the Experimental farm of the Edinburgh and East of Scotland Agricultural College at Boghall. But Miller will be remembered most for his work on the experimental farm at Rothamsted and Woburn where he was manager from 1927 until his death.

Of the many tasks which Miller had to tackle at Rothamsted his zeal in solving the problems of cultivation which the new statistical treatment of experiments demanded was perhaps the most noteworthy. He achieved amicable collaboration between the views of the cultivator and statistician and so contributed much to the success of this important aspect of Rothamsted's work. Also, the system of farming now adopted of mixed grass and arable, involving the carrying of a large head of livestock where previously there was none, is in great measure due to his energy, skill and tactful organisation.

PRINCIPLES OF BANANA BREEDING.—*Concluded.*

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3. Breeding from Minor Varieties.

In making pollinations on varieties other than Gros Michel and the various Cavendish types there is always a chance that directly useful seedlings might result, but most of the varieties concerned are too far removed from the major commercial types to render the chance anything but remote. The primary object of this work was to discover the seed producing capabilities of the various forms in the collection and the kind of progeny each would give. Such information must be useful, but the precise use to which it might be put was not at first apparent.

So that results should be comparable, one plant was used as pollen parent as far as possible, namely *M. acuminata* Clone B (*M. malaccensis B* of earlier publications). Other clones of *M. acuminata* were used when pollen was short, and the results are counted in. When the figures from this species were considered adequate other species were brought into use.

At the end of the period under review a few varieties had not been grown on a sufficient scale for the results to be significant, but the "analysis" of the collection by *M. acuminata* was nearly complete and a similar analysis by *M. sapientum* (*sensu* Roxb.) was well under way on the more freely seeding varieties. Table 3 shows the seed-producing capabilities of all varieties with pollen of *M. acuminata*, Gros Michel and the Cavendish c'ones being included for comparison.

It will be noted that 20 of the 25 clones have been classified, and one other found to set seed though further evidence is needed to show whether it is a "sparse" or a "free" seeder. Four have given no seeds, but cannot be classed as "sterile" on the evidence of less than ten consecutive failures. As an arbitrary standard for minor varieties, *i.e.*, those without combinations of characters of outstanding commercial promise, ten consecutive negative results from pollination with one kind of pollen are taken to indicate that that particular cross is economically not worth making. So much remains to be done with more amenable varieties that some such line must be drawn, and attention is more profitably directed to the types which seed freely, or possess characters of promise.

The terms "sparse" and "free" are also applied quite arbitrarily and purely as a matter of convenience. Sparse seeders are those giving on the average less than one seed per bunch, and "free" seeders those giving more than one, though the production of one seed from a hundred or more flowers, with many thousands of ovules, is hardly free seeding in any usual sense of the word. It is to be noted that the freely seeding types do not possess all the advantage that would appear from Table 3, because in most cases their germination percentage is much lower than that of some sparsely seeding types, and more seeds are needed to give an adequate progeny for study. For

Table 3.

Seed Production with Pollen of *M. acuminata*.

Standard Clone.	Bunches cut.	Seeds found.	Classification.
Type 1 (Gros Michel)	58	50	Sparse
Type 2 (Dwarf Chinese)	54	nil	Sterile
Type 3 (Giant Chinese)	17	nil	Sterile
Type 4 (Congo)	20	1	Sterile
Type 5 (Masak Hijau)	260	(8) ?	Sterile
Type 6 (Mysore)	32	334	Free
Type 7 (Red)	30	720	Free
Type 8 (Orotava)	19	190	Free
Type 9 (Male)	1	0	Undetermined
Type 10 (Rio)	2	6	Undetermined
Type 11 (Bluggoe)	17	237	Free
Type 12 (Awak Legor)	1	100	Free
Type 13 (Un-named)	25	19	Sparse
Type 14 (Un-named)	15	nil	Sterile
Type 15 (Pome)	15	140	Free
Type 16 (Maruthuva)	26	10	Sparse
Type 17 (Silk)	18	9	Sparse
Type 18 (Rajah)	9	28	Free
Type 19 (Sucrier)	11	2	Sparse
Type 20 (Un-named)	11	2	Sparse
Type 21 (Palembang)	3	0	Undetermined
Type 22 (Bande)	1	0	Undetermined
Type 23 (Plantain)	10	4	Sparse
Type 24 (Horn)	8	2	Sparse
Type 25 (Otaheite)	0	0	Undetermined

example, whereas of the 50 seeds from Gros Michel 14 germinated (28 per cent.), the germination from Type 6 (Mysore) was only about eight per cent., from Type 7 (Red) six per cent. and from Type 12 (Awak Legor) none of the 100 seeds found in a single bunch germinated. These low percentages are almost certainly expressions of sterility.

Chiefly on account of low germination rates the kind of progeny which each of the clones will give has been investigated in only five cases. The results are nevertheless interesting for the variety that they exhibit within such a narrow range of experience, and details will be given for each of the five types in turn.

Type 6 (*Mysore*).

The "Fillbasket group" of the former Report (14, p. 28) was definitely reduced as expected to a single variety, adopted as Type 6 with *Mysore* as the best authenticated name. This variety has proved the most useful in the collection for genetical investigations on account of its comparatively free fertility with foreign pollens, and now serves as an "analysing" female parent for testing the value of new males brought into use. At the same time it has many excellent economic qualities, and ranks high among the minor varieties of promise as breeding material. On the male side it is for practical purposes completely sterile, producing only one or two pollen grains per anther, whereas most of the sterile clones produce a few dozen grains at least.

Its pollination record in the period under review is as follows:—

Male Parent.	Bunches cut.	Seeds found.	Germinations.
M. acuminata ..	32	334	25+
M. sapientum ..	24	133	23
M. textilis ..	2	nil	—
Type 4 (Congo) ..	19	nil	—
Type 1 (Gros Michel)	8	nil	—
I.C. 1 ..	40	25	6

The behaviour of Mysore when crossed with *M. acuminata* is like that of Gros Michel. The first ten seedlings raised, as already reported elsewhere (17), comprised five robust tetraploids, four thick-leaved dwarfs (2n=about 73-75 in two cases investigated) and one triploid of slender habit and abnormal flower characters, of no practical interest. In the tetraploids the influence of *M. acuminata* is more marked than in the case of the Gros Michel seedlings, the fruit being less like that of the female parent, and in one case at least not parthenocarpic. Nevertheless they are essentially analogous, and like I.C. 1 they cross back readily to *M. acuminata* giving plants with still more of the characters of that species, most probably triploids.

The progeny with pollen of *M. sapientum* (*sensu* Roxb.) is uniform and very robust, with a particularly well-shaped bunch, and whilst probably of no direct value may well prove on further study to be useful stock for further breeding.

The progeny by I.C. 1 pollen is interesting because, with the exception of a single backcross plant from Gros Michel mentioned above, this is the only triploid × tetraploid combination effected, and gives the first clue to the probable value of that combination in general.

Six plants raised to the flowering stage look very much alike. Two on examination proved to be pentaploids (2n=55) and probably the others are the same. They are fairly vigorous, resembling edible bananas in habit and stature, their fruit develops parthenocarpically and they produce fairly abundant pollen. Their fruit, however, is smaller than that of either their triploid or their tetraploid parent, and they have no direct commercial value. Their occurrence is chiefly interesting as an indication of the wide range of possibilities in banana breeding. A seventh seedling, of dwarf habit, had 2n=approximately 90, the highest number yet found in the banana complex.

The failure of pollen from the two triploid clones Congo and Gros Michel to set seed on Type 6 is noteworthy in view of the general fertility of the latter.

Type 15 (*Pome*).

This variety, obtained from Teneriffe, behaves like Mysore in crosses by *M. acuminata*. Fifteen bunches harvested yielded 140 seeds, of which more than 25 germinated but not all the seedlings were retained. Just as in the cases of Gros Michel and Mysore the majority of the progeny are robust plants, probably tetraploid though not yet examined for chrosome number. Thick-leaved dwarfs also occur in similar proportions (2n=77±), with occasional slender plants, possibly triploids.

Seven bunches pollinated by *M. sapientum* set no seed, and it will be interesting to see from later results whether Pome proves quite sterile to this pollen or not. Relative cross-fertilities and sterilities are likely to be of assistance later in determining the relationships of the sterile clones.

Type 11 (*Bluggoe*).

Whilst the progenies obtained by *M. acuminata* out of Types 1, 6 and 15 are essentially similar, containing robust tetraploids, thick-leaved dwarfs approximately heptaploid, and occasional triploids, seedlings from the cross Type 11 × *M. acuminata*, are entirely distinct. Bluggoe is a triploid clone, but even to the most superficial observation is far removed from Gros Michel in affinities. It is indeed the clone which approaches most closely of all the edible types in the I.C.T.A. collection the characters of wild *M. sapientum*, and it may well have been derived from that species without admixture of any other.

It sets seed freely enough with pollen of *M. acuminata* as well as with that of *M. sapientum* (*sensu* Roxb.) In act the seeds set with the former pollen are more numerous than those with the latter, but in both cases many of the seeds are empty. The full pollination record for this variety is:

Male Parent.	Bunches cut.	Seeds found.	Germinations.
M. acuminata ..	17	237	31+
M. sapientum ..	15	44	3
Type 1 (Gros Michel)	4	nil	—
Type 4 (Congo) ..	2	nil	—

The seedlings by *M. acuminata* do not resemble edible bananas, but from their youngest stages look more like wild *Musa* species. When they flower, their floral characters show the influence of both parents, but the inflorescence and fruit bunch are both comparable in size to those of *M. acuminata*. The fruit is not parthenocarpic, and if unpollinated fails to swell. The male flowers are often highly irregular in the arrangement of their parts. Examination of chromosomes in eight individuals showed six of them to be diploid (2n=22), and two which were specially included in the counts because they showed *less* vigour in their young stages than the majority proved to be tetraploid; the latter subsequently died.

It thus appears that Bluggoe must produce a fair proportion of haploid egg cells, and therefore behaves in breeding most commonly as though it were a diploid. Comparison of the seedlings with those raised from crosses between *M. acuminata* and fertile (diploid) *M. sapientum* reveals few differences, and none genetically fundamental.

After four failures on different individuals, one of the seedlings set seed with pollen of *M. acuminata* and half a dozen plants of the back cross were raised. They are still too young for study, but should prove interesting.

In view of the probable origin of Bluggoe, the cross by fertile *M. sapientum* might be expected to prove interesting. Unfortunately only one of the three seedlings survived the nursery stage and that is not robust, so that no good opportunity has yet arisen to study its constitution or behaviour. More seedlings raised subsequently from the same cross are also weakly, which is rather surprising.

Type 7 (Red).

This, according to our varietal studies and general information is the most common and widely distributed red-fruited banana, known in almost every banana growing country. It is well known to produce quite frequently by somatic mutation a yellow-fruited sport, with less red pigment also in the vegetative parts. Pollination results from both Red and its "Green Red" subtype are pooled, since although they are separated in the records there is no difference in genetic behaviour between the two. The results are:

Male Parent.	Bunches cut.	Seeds found.	Germinations.
M. acuminata ..	30	720	45
M. sapientum ..	6	1	nil

There is not, to outward appearance, nearly so much difference in affinity between Red and Gros Michel as between Gros Michel and Bluggoe, but the seedlings from Red by *M. acuminata* are sufficiently distinct to suggest that this clone represents an entirely different group of banana varieties, possibly of quite different specific origins.

From the standpoint of direct usefulness all the seedlings are entirely worthless, although their female parent is a not unpromising stock by its economic characters. Many of them are weakly or abnormal from their earliest seedling stages and do not survive the nursery. Two such plants examined for chromosome number proved to be triploids (2n=33). The more robust plants have not yet been examined in this respect, but they exhibit a great variation among themselves, which is in sharp contrast to the relative uniformity of the tetraploids raised from Types 1, 6, and 15.

Type 8 (Orotava).

This is "Coccinea" of the 1931 Report (14. p. 29) re-named after its place of origin to avoid possible confusion with *Musa coccinea* Andr., which it in no way resembles. Points in its morphology and also in its breeding behaviour suggest that it may possibly be related to Type 7, but not very closely. Its pollination results are:

Male Parent.	Bunches cut.	Seeds found.	Germinations.
M. acuminata ..	19	190	10
M. sapientum ..	11	nil	—
M. ornata ..	1	2	nil

The difference in cross-compatibility with *M. acuminata* and *M. sapientum* is significant and interesting.

The progeny by *M. acuminata* are very mixed, including a few vigorous plants (probably all tetraploids, though only one has yet been examined cytologically and proved to have 2n=44) and a larger proportion of slender or stunted seedlings, reminiscent of those raised from Type 7. One of the latter has been examined and found to be a triploid (2n=33).

Sterile Diploid Clones.

The diploid clones among the edible bananas in the collection are Types 19, 20, 21 and 22. The records from them are meagre, but it is worth mention in passing that they are evidently more sterile than many of the triploids. No seedling has yet been obtained from any of them. They are, however, worthy of more extended study from one point of view at least. On the hypothesis that they are hybrids between distinct species, which seems not unlikely, there is a possibility that on pollination with either of their parents they might give triploid progeny and at the same time reveal their origins. They have thus potentialities of usefulness in that part of the research which remains to be discussed in the next section.

Breeding by Species Crossing.

D'Angremond (3) made a cross between *M. ornata* Roxb. and *M. zebrina* Van Houtte (synonymous with *M. acuminata* as used here) both of which are diploid species. The F1 was in neither case uniform, indicating that one or both of the parents was heterozygous. From observations in Trinidad of *M. zebrina* received from Java, the heterozygosity was probably on that side. The F1 had scanty pollen, and it was with some difficulty that an F2 was raised. The F2 had not flowered when the paper was written but *appeared quite uniform.* The F1 was back-crossed by both parents, and each of the progenies was *uniform within itself.* The plants were not parthenocarpic, and produced more pollen than the F1. Chromosome counts showed that in the F1, 2n = 22 as in the original parents, but in the meiotic divisions of back-cross plants higher numbers were found, up to 44, and never less than 33. D'Angremond considers that unreduced eggs of the F1 have been fertilized by haploid pollen in the back crosses, and that his counts of 33 to 44 at the first meiotic division of the back-cross plants are due to premature splitting of the chromosomes from the unpaired set in the complement. This seems most probable, and in that case the back-cross plants are probably all triploids. In any case they are undoubtedly polyploids, experimentally raised, and the fact opens up a wide field of possibilities in banana breeding.

A similar cross, employing a different clone of *M. acuminata* and probably a slightly different form of *M. ornata* also, was made at the Imperial College of Tropical Agriculture in October, 1926, d'Angremond's work being at that time unknown to the writer. It was made both ways, and large progenies resulted from both matings. They proved to show characters of both parents and did not vary more than might be attributed to their different positions in the field. Eight individuals examined for chromosome number had 2n = 22. All but one were destroyed. The one was selfed and back-crossed by both parents, with exactly the results obtained by d'Angremond, F2 and each of the back-cross progenies being uniform within themselves. Chromosome counts have not been made, since other work pressed and d'Angremond's were considered adequate. The F2 will be examined when time permits, as there appears a distinct possibility that it may be tetraploid.

If similar behaviour proves to be characteristic of other species crosses in *Eumusa*, it appears that we have probably only to find the right parent species in order to synthesize an edible triploid banana. At the least the possibility is sufficiently strong to justify extensive investigation of species crosses.The evidence supports the hypothesis that the edible bananas most probably originated in a similar way in Nature, and from the strictly practical point of view there is as much to commend this method of attacking the economic problem as there is to support any other. In particular the method is rapid and inexpensive, since a single pollination usually yields abundant seeds. Its outcome is at present speculative, therefore it cannot replace lines previously discussed, but side by side with them it has a definite place in future researches.

At the end of January, 1932, the interspecific hybrids which had been raised comprised 14 distinct combinations of different clones of *M. acuminata* with clones of *M. sapientum* (*sensu* Roxb.), *M. sapientum* × *M. ornata* and *M. sapientum* × *M. texilis.* Reciprocal crosses were also effected between *M. acuminata* and a plant received from Malaya as *M. truncata* Ridl., but it is not certain that this plant is specifically distinct from *M. acuminata* itself. Several more combinations have been made since, and it appears that many of the species of *Eumusa* intercross quite readily. The hybrids are in every case clearly recognizable as genuine by their combination of parental characters, and there is for the present no more to be said about them. It is from further intercrosses and back-crosses that the most interesting information is likely to accrue, and this part of the programme is virtually just commencing.

The Present Programme.

The conclusions to be drawn from the data presented can be most conveniently summarised by outlining the revised programme of researches based upon them. On the working hypothesis that the basic haploid chromosome number of the banana complex is 11, seven important facts have been established:

(1) That such fertile *Eumusa* species as have been investigated are diploid.
(2) That the majority of established edible bananas investigated are triploid, and a few diploid.
(3) That some of the most important triploid clones on pollination by diploid species give tetraploid progeny.
(4) That some tetraploid bananas have the general habit and characters of commercial varieties.
(5) That tetraploids are in general more fertile than the corresponding triploids.

(6) That tetraploids crossed with diploid species may give triploid progeny.
(7) That polyploids may arise in later generations from crosses between distinct diploid species.

It is reasonable to conclude that a new seedling of commercial usefulness may be diploid, triploid or tetraploid, but is most likely by analogy with existing varieties to be triploid. Viewed in this light, breeding from edible varieties, including Gros Michel, resolves itself into the production of tetraploids which may either prove directly useful or serve as breeding stock in place of their less fertile triploid parents. Breeding from fertile species resolves itself into the production of new polyploids, which again may be directly useful or indirectly valuable as material for further crosses. Triploids, in short, may be produced by synthesis from diploids or by reduction from tetraploids.

The main object of the next phase of the researches must be to discover the right material to be used. The methods of effecting triploid combinations are fairly clear, but which sets of chromosomes should be combined by those methods for the best results? Any clue which will indicate the sets used by Nature in producing the established varieties will help to solve the problem. Alternatively it may be solved empirically, by trial and error. By either line of approach, emphasis is laid on the importance of collecting and studying as many species and varieties as possible. With an adequate collection, whilst attempts are made to diagnose the constitution of the varieties in terms of the species, the maximum number of promising crosses can be investigated empirically.

Re-classifying the breeding stock already available, according to its polyploid status, the theoretically possible crosses involve six distinct types of mating, viz.:

1. Diploid with diploid.
2. Diploid with triploid.
3. Diploid with tetraploid.
4. Triploid with triploid.
5. Triploid with tetraploid.
6. Tetraploid with tetraploid.

In practice the intercrossing of triploids has given no result, and whilst it is probably not impossible it seems very doubtfully worth while as long as more fruitful lines remain largely unexplored. Similarly the combination of triploids with tetraploids, though it needs further trial in the interests of knowledge, is unpromising from the present evidence. The main lines for the second phase of investigation are therefore reduced to four.

1. *Intercrossing diploids* is practically synonymous with species crossing. It has already been mentioned however that the sterile diploids have a possible use in elucidating relationships. The potentialities of this line have been sufficiently discussed.

2. *Crossing triploids by diploids* has comprised the bulk of the work of the preliminary phase but needs continuing for more than one reason. The reciprocal mating is unprofitable. It is desirable under this head (*a*) to complete the "analysis" of standard clones (*b*) to raise more tetraploids for further breeding, enlarging the range of tetraploid material available and (*c*) not least to continue attempts to raise a commercial tetraploid, especially from Gros Michel.

3. *Crossing diploids with tetraploids* is an unworked line, except for the few cases in which I.C. seedlings have been back-crossed to their own fertile parent. It offers large possibilities of producing new triploids, even from the material already available.

4. *Intercrossing tetraploids* is (with the single exception of the cross I.C. 2 × I.C. 1) an entirely unworked line, only possible since a number of I.C. seedlings have become available for use. In the total absence of data its potentialities are matters of speculation but two possibilities are in mind in its adoption. First, it affords a means of combining in one plant characters from two triploids which cannot be crossed directly. Secondly, there is the hope that two partly fertile tetraploids of different constitutions may combine to give completely sterile offspring, which would be a long step towards the ultimate goal.

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During the period covered by the pollination records the work was partly financed by the Empire Marketing Board as part of the wider scheme of Banana Research centred on the Imperial College of Tropical Agriculture, though it commenced some years before the other branches and has throughout been an integral part of the College research programme. From the commencement the lively interest and support of successive Principals of the College—the late Sir Francis Watts, Dr. H. Martin Leake, and for the greater part of the time Sir Geoffrey Evans, has been an essential factor in the progress made. The contributions of Professors Mason, Harland, Ashby and Dash to the earlier stages have been mentioned in a previous publication. Many present members of the College staff have been called upon for assistance from time to time, and particular mention must be made of Dr. C. W. Wardlaw and the late Dr. L. P. McGuire for their willing help in storage trials of varieties and seedlings and in banana disease problems. Without the zealous assistance of Mr. G. E. L. Spencer on the field side, in varietal studies and in supervision both of pollinations and of cultivation, much of the work reported could never have been done.

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same connection the services of the Imperial Institute of Mycology in supervising the quarantine of introductions cannot be overlooked.

Requests for seed of *Musa* species or other material made either direct or through Kew have enlisted an army of helpers, to whom collectively much of the credit will be due if our problem is ultimately solved. Material has at one time or another been received from the East African Research Station, from the Directors of Agriculture or their officers in Barbados, British Guiana, Burma, Ceylon, Federated Malay States, Jamaica, Madras, Mauritius, Mysore, New Guinea, North Borneo, Sarawak, Seychelles and Trinidad, from Botanic Gardens at Buitenzorg, Calcutta, Orotava and Paramaribo, from the College of Agriculture, Philippine Islands, and from individuals in Celebes, Samoa, the British Solomons, Northern Solomons, and Queensland. To all concerned is due not only thanks but grateful recognition of the fact that collection of seed from wild species must often be an arduous task.

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(Note.—This bibliography contains not only literature cited in the text, but also references to other papers relevant to the taxonomy, genetics or breeding of the group.)

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NOTES ON COVER CROPS IN DOMINICA.

July, 1934.

Herbarium determinations received from Kew since publication of this article necessitate the following corrections in botanical nomenclature :—

For *Crotalaria spectabilis* read *Crotalaria sericea*.
For *Crotalaria oocarpa* read *Crotalaria vasculosa*.
For *Cajanus indicus* read *Cajanus Cajan* (*C. indicus*).
For *Gliricidea maculata* read *Gliricidea sepium* (*G. maculata*).

GOLD COAST COCOA.

Cocoa Industry Regulation Ordinance, 1934.

A Bill has been introduced to the March meeting of the Gold Coast Legislative Council to give effect to the recommendations of the report of a Committee appointed by the Governor to consider the feasibility of prescribing a standard of quality below which no cocoa may be exported from the Gold Coast. This Committee which was representative of the various interests concerned agreed unanimously that the export of markedly inferior cocoa should be prohibited and that legislation should be introduced forthwith requiring all cocoa to be inspected prior to export and enabling the prevention of the exportation of cocoa below a specific quality standard.

The standard of quality proposed is :

(*a*) Not more than 50 per cent. by count of unfermented or insufficiently fermented beans, the internal colour of which is slate grey ;

(*b*) Not more than 20 per cent. by count of broken, flat, decayed, mouldy, weevilly or germinated beans, in which there must not be more than 10 per cent. of weevilly or more than 10 per cent. of mouldy beans ;

(*c*) Not more than 8 per cent. of moisture.

The standard set is a low one but it is an important step towards raising the quality of Gold Coast Cocoa.

CHIMERA IN DATES.

Chimeras have been reported in the following fruits :—apples, grapes, lemons, olives, oranges, and pears ; but there appears to be no mention of the occurrence of this phenomenon in dates. One date chimera, however, was seen by the writer last date season.

The palm bearing this date was growing at Du'ayji, near the Kut as-Sayyid Estate, in Basrah, 'Iraq. The variety was Lului. It was noticed on 25th September, 1933. The weight (with pit 8.8 gm., without pit 7.5 gm.), and size (of date, 2.3 cm. long by 3.0 cm. wide, of pit, 2.1 cm. long by 1.0 cm. wide), and shape (subspherical) of the date were normal for the stage of ripeness reached, namely the *khalal* or fully grown, brightly coloured stage just before the flesh softens. At this stage, dates are usually yellow, varying from lemon to chrome, though many varieties are carmine. A few varieties are yellow more or less evenly suffused or flushed with carmine. Lului dates are deep-lemon yellow in the *khalal* stage, but this chimera showed carmine as a mutant colour. When the date was looked at from the apex, or from the base, the circle, which thus appeared, was divided into four sectors, alternating yellow and carmine. The angles subtended at the apex and the base by these sectors were, 80° (yellow), 80° (carmine), 130° (yellow), and 70° (carmine). The last had two incomplete thin yellow streaks included.

V. H. W. Dowson.

NOTES ON SOME INSECT PESTS IN THE LESSER ANTILLES.

By H. A. Ballou.

A Wood-Boring Caterpillar, *Duomitus punctifer.*

During the last thirty years, Whitewood or White Cedar trees (*Tecoma leucoxylon*) in Barbados and St. Kitts have been seriously damaged by the larvae of *Duomitus punctifer* Hampson. This moth is a member of the family Cossidae, which includes the goat-moths of temperate climates and to which belongs *Zeuzera coffeae*, the well-known borer of coffee, tea, cacao and many other plants in the Eastern tropics. In India, *Duomitus ceramicus* is recorded as boring in wood and causing serious injury.

Duomitus punctifer was described by Sir George Hampson (1) in 1898. The moth is dull grey in colour, slightly tinged with pink; delicate, broken, brown lines run across the fore-wings. The female has a wing expanse of 2½ inches; the male is somewhat smaller. The female is heavy-bodied and sluggish in flight, the male of slighter build and more active. Both male and female are attracted to light. The eggs are laid on or in a small twig. The newly hatched larva penetrates into the centre of the twig and works its way into the larger branches, where it feeds until full-grown. The full-sized larva is a dirty-white caterpillar, sometimes as much as two inches long and half an inch in diameter. Just before pupating it eats its way to the surface, leaving only a thin film of bark which is broken through by the pupa before the moth emerges. When this happens, about half of the empty pupa case is left protruding from the tunnel. The injury to the branches often results in their death or breaking off at weakened points.

The known distribution and host-plants of this moth are as follows :—

Barbados: Gliricidia, Tecoma, Croton, Soursop, Ipomoea, Barbados Cherry, Tangerine.
St. Kitts: Tecoma, Gliricidia, Camphor.
Nevis: Tangerine, Orange, Coffee?
Montserrat: Sapodilla.
Antigua: Soursop?
St. Lucia: Guava.
St. Vincent: Pithecolobium, *Tabebuia pentaphylla*.
Jamaica: Host unrecorded.
Puerto Rico: Orange, Citron, Rose Apple, Sweet Almond.

The records from coffee in Nevis and soursop in Antigua are queried because the identifications were based on the appearance of the tunnels in the wood.

The first records of the moth, those of Hampson (1) in 1898, were from St. Vincent, Dominica, St. Lucia and Grenada; other records have appeared from time to time in the *Agricultural News* and elsewhere (2-5). The moth is probably indigenous to the more wooded islands in the Lesser Antilles. It appears to have been unknown in Barbados until 1911 or 1912, and has probably been introduced to that island, perhaps at the port of Bridgetown. It appears to have spread only a short distance, but in the neighbourhood of Bridgetown, especially in comparatively dry situations, many fine Whitewood trees have died, probably from the attacks of this pest. In St. Kitts a row of Whitewood trees which formed a wind-break at the old Botanic Gardens was killed by it.

The suggestions for the control of this pest are the same as for many other wood-boring caterpillars and beetle larvae. All infested branches should be pruned out, and the prunings and all fallen branches should be promptly burned in order to kill any eggs, larvae or pupae within them. If it is not advisable to cut out caterpillars in the larger branches, they may be killed by probing in their tunnels with a stiff wire.

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Jack Spaniard Wasps and the Cotton Worm.

Cotton growers in St. Vincent have suffered but little from the attacks of the cotton worm, the larva of the moth *Alabama argillacea*, since they started the cultivation of Sea Island Cotton about 30 years ago. In the other cotton growing islands the cotton worm has been present usually to the extent of being a pest in nearly every season. This comparative immunity in St. Vincent has been due, without doubt, to the influence of the natural enemies of the cotton worm, predaceous and parasitic insects that attack it in its several stages. It should be noted that *Alabama argillacea* does not live in these islands from one year to another. At the end of the season the moths migrate, and in the following season invasion results from stragglers which alight from great swarms migrating probably from South America northward. Probably, also, a few of the moths reach these islands every year.

In St. Vincent, the cultivation of Sea Island Cotton started in 1903-04. The cotton worm was first noticed in 1906-07. Since then it has been recorded as occurring in St. Vincent in 16 seasons, while in 15 seasons there is either no mention of it in the Annual Reports or a definite statement that the insect did not occur or was not reported. In some six years there is a record of the use of poison for the control of the pest. The first recorded attack occurred in 1907, a slight attack in which no damage was done as the worm was controlled by natural enemies, principally Jack Spaniards, which are wasps of the genus *Polistes*. The second recorded

attack occurred in 1912. The wasps were abundant, but poisons were necessary to control the pest. In addition to the Jack Spaniards, an internal parasite, *Chalcis* sp., was noted. In 1922, a slight attack, very local, required the application of insecticides. Since that time there has been no general attack, and only two local attacks requiring the use of insecticides. The records indicate, then, that the cotton worm has been observed as occurring in St. Vincent in 16 seasons, in six of which it has appeared in such numbers that poisons have been used for its control. In other seasons the invasions have been met by the action of its natural enemies.

The records of the cotton worm in other islands are quite different. From the beginning of cotton cultivation, it has been recorded as occurring in greater or less numbers, but there is never any suggestion that natural enemies have controlled it. Whenever artificial control has been maintained, arsenical poisons have been used. In St. Kitts, for instance, in 23 seasons attacks of cotton worm were controlled, or control attempted, by the use of insecticides.

The natural enemies of an insect of this kind are many. They include birds, toads, lizards, the predaceous wasps of the genus *Polistes*, a parasitic wasp-like insect of the genus *Chalcis*, egg-parasites of the genera *Trichogramma* and *Telenomus*, and a predaceous beetle, *Calosoma calidum*. *Calosoma calidum* as an enemy of the cotton worm is interesting but not abundant enough to be important. The other natural enemies may be presumed to have about as much influence in one island as in another, except in the case of the Jack Spaniard.

In St. Vincent the Jack Spaniard is *Polistes annularis*, in the Leeward Islands *P. crinitus*. In Barbados there are two species of these wasps: *P. annularis*, known as the Wild Bee, and *P. bellicosus*. All these species of *Polistes* are known to be predaceous on caterpillars and other insects. In the Leeward Islands, the Jack Spaniard is very far from abundant; in Barbados the two species taken together are far less numerous than the one in St. Vincent. So valuable was the St. Vincent wasp believed to be in the control of the cotton worm that cotton growers in that island built shelters in the fields to encourage the insects to nest there.

Attempts were made to establish *P. annularis* in Montserrat, St. Lucia and Antigua, but they met with little success. The first introductions from St. Vincent to Montserrat in 1910 appeared to be establishing themselves, when in 1912 a disease appeared in the nests. Later the same disease was found in nests which were sent to Antigua from Barbados. The so-called disease was due to the attacks of a small moth, *Calcoela* (*Dicymolomia*) *pegasalis*, whose larvae invade the nests and kill the wasp larvae. This moth is recorded as occurring in the Southern United States and the West Indies. It has been reared from the nests of *Polistes* in Montserrat and in Barbados. It is probable that this insect is responsible for the comparative scarcity of the Jack Spaniard in the Leeward Islands. In Barbados, in recent years, the two species of *Polistes* have largely disappeared from many of the localities where formerly they were easily to be found. At the present time there is no record of the moth in St. Vincent and there is no noticeable diminution in the numbers of Jack Spaniards. They are reported to be very abundant still and much in evidence in the season, hunting on the cotton plants in search of the cotton worm and other insects.

This appears to be an instance of a group of native insects being exterminated by one of their natural enemies. Attention is attracted to this occurrence because of the economic importance of the disappearing insects.

* * *

Sweet Potato Weevils.

The sweet potato weevils have recently extended their range in the West Indies.

There are two species of these weevils, which are among the most important pests of the sweet potato: *Euscepes batatae* Waterh., known in the Lesser Antilles as the Jacobs or Scarabee, and *Cylas formicarius* Fabr., which is the insect generally known as the sweet potato weevil. Both species are now very widely distributed. *Euscepes batatae* has been reported from the Lesser Antilles, Puerto Rico, Jamaica, Brazil (which may have been its original home), British Guiana and in the East from localities as widely separated as China and New Zealand, Fiji, Guam and Hawaii. *Cylas formicarius* was described from India and is now distributed throughout the tropics and sub-tropics: from the southern United States to the Argentine, throughout the Oriental and Pacific regions from China and India to Australia, and in many parts of Africa, where there is also a related species of *Cylas*, of habits similar to those of *C. formicarius*.

The adult *Euscepes batatae* is a short, plump beetle about one-eighth inch long, almost black with a light band across the hind part of the wing covers. *Cylas formicarius* is about the same size, but elongated and slender, somewhat ant-like in appearance, with brilliant metallic colours, yellowish on the thorax and deep steel-blue on the head and wing covers.

The two weevils which, are similar in habits, damage the sweet potato in the same way. The eggs are laid in the vines, especially the older vines, and in the roots, when these are exposed or insufficiently covered with earth. The grubs tunnel in the tissues of the plant and the pupae are formed in the larval tunnels. The adult *Cylas* beetles feed on the foliage of the sweet potato plants. The effect of the feeding of the weevil grubs is to render the attacked tubers unfit for food. Even if only a very small part of the potato has been invaded by the insects, such a disagreeable odour develops that it is not fit for human consumption and will not be eaten even by cattle and pigs. If infected potatoes are

stored or kept for any time in the ground the attack goes on, a new generation developing every three or four weeks.

The control of these weevils depends on the planting of clean or non-infested slips, the protection of the developing tubers by keeping them well covered and the most thorough clean-up possible after the crops are gathered.

In the Lesser Antilles the principal sweet potato weevil is *Euscepes batatae*. It was first described from Barbados in 1849. It was considered even then to be a serious pest in Barbados, and for many years it has been known to be injurious in all the Windward and Leeward Islands from Grenada and Carriacou to St. Kitts and Nevis. Its occurrence in Trinidad has been noted quite recently, in 1931. Sweet potatoes are not an important crop in Trinidad, and it is possible that the scarabee was present in the island, but unnoticed, for some time before 1931.

The known range of *Cylas formicarius* has been extended by recent reports of its occurrence in St. Kitts (1931), Anguilla (1931) and St. Eustatius, in the Dutch Islands (1933). It appears to be the only one of the two sweet potato weevils that occurs in the Dutch Leeward Islands, and it is probably this species that has been so long known in Anguilla. If this be the case, it is strange that it has not appeared earlier in St. Kitts, since there has always been frequent communication by schooner between St. Kitts and both Anguilla and St. Eustatius.

THE ROOT SYSTEM OF COFFEA ARABICA.*

By F. J. Nutman.
(*East African Agricultural Research Station, Amani, Tanganyika*).

Arabica coffee is grown over a wide range of soils and conditions in East Africa. The soils vary from the deep almost unweathered volcanic ashes of Mount Meru to heavy clays. The acidity profiles vary also; some are neutral or slightly alkaline at all depths, some comprise a surface layer near neutrality, overlying a more acid subsoil, while others are acid throughout. Rainfall may vary from 80 to 100 inches in one area to 20 to 25 inches in another.

The root system of coffee varies very considerably from area to area, as might, indeed, be expected, but from a consideration of the 67 systems so far excavated, it is possible to define what may be called the typical root system of *C. arabica*. This is characterised by the absence of a tap-root, by the development of a number of vertical axial roots, and by the laterals turning downwards at varying distances from the trunk, giving rise to a system of roots which are evenly dispersed throughout the soil to a depth of nine feet or so, although in some districts they may be found at 14 feet from the surface.

This system may be modified by local soil conditions, such as rock and gravel strata, dry hardpan, high water-table and so on, whereby penetration of the roots may be more or less restricted.

The effects of soil acidity on the roots, as brought out by field studies, is perhaps worthy of special mention. Coffee has previously been assumed to be an example of a plant which requires an acid soil for its optimum development. Comparison of the distribution of the roots with the acidity profile of the soil shews that this is not the case. Soils which are acid throughout shew very poor root development at all depths: where an acid subsoil underlies a top-soil which is neutral or moderately acid the feeder roots are virtually confined to the surface soil: but where the soil is neutral or nearly so throughout, the roots are found to be evenly dispersed. From field evidence only, and pending confirmation by experiment, the optimum acidity for coffee root growth is on the neutral side of pH 5.8.

One of the more serious problems in East African coffee culture is that of "overbearing and dieback". The young tree sets a heavy crop, only part of which matures. This is followed by leaf fall, the drying up of the crop, and the dying back of the branches. The tree rarely recovers completely, and at the best is a "passenger" for some years. The dieback of the branches is paralleled by dieback of the roots, the regeneration of which appears to take place with difficulty if at all. The roots in the surface soil seem more resistant to this subterranean dieback than the more deeply seated ones, or possibly they regenerate more readily. At any rate a tree which has had dieback is frequently found to be reduced to surface rooting, in areas where the natural habit may be the reverse.

In some areas, where the roots are confined to the top-soil by an acid sub-soil, excellent coffee trees can be grown by the use of considerable quantities of organic manure. It therefore appears possible that the correct treatment for trees subsequent to dieback is to increase the fertility of the top-soil, in order to provide a sufficiency of nutrients within the suddenly restricted range of the root system.

* A summary of "The Root System of *Coffea arabica*," Parts I and II. *Empire Jour. of Expt. Agric.*, Vol. 1, 3 and 4, 1933.

AGRICULTURAL NOTE BOOK.

Copies of Professor Wood's "Note-book of Tropical Agriculture" (price 5 shillings) may be obtained on application to the Editor, *Tropical Agriculture*, Imperial College of Tropical Agriculture, Trinidad, B.W.I.

REVIEWS.

Denudation and Soil Erosion in Nyasaland.

By A. J. W. Hornby. Department of Agriculture Bull. No. 11. (New Series). Government Printer, Zomba, Nyasaland. pp. 32.

To quote a recent editorial in this Journal (Vol. XI, p. 77), Mr. Hornby, the Assistant Director of Agriculture in Nyasaland and Agricultural Chemist, has "performed a great service to tropical agriculturists in again forcibly stressing the menace of erosion in relation to the general question of the maintenance of soil productivity". In all parts of the Tropics, as agricultural departments are getting down to their jobs and increasing their knowledge of the practices of their local agriculture, whether under an exotic capitalistic system or by the indigenous peasant, it is being more and more realised that the losses caused by denudation and soil erosion are serious, and that they tend to become cumulative.

Mr. Hornby's bulletin is therefore very welcome, for it possesses more than local application. In the general discussion of this problem, which occupies Part I, perhaps the most interesting section is that which deals with the past and present state of Nyasaland, and gives definite historical evidence of the rapidity with which the face of the country has been changed. Within the memory of living men, wide tracts have been denuded of their forest canopy, with consequent cessation of the streams, leading in some cases to complete abandonment of farming operations.

Although the soils of Nyasaland, as far as investigation into their erosibility has proceeded, do not appear to be particularly susceptible, this advantage is offset by some of the agricultural practices to which the local peasant is addicted, notably the extent to which he likes to burn over his land before planting it. Undoubtedly, the destruction of weed seeds, and the partial sterilisation of the soil are benefits which result, but the practice is terribly wasteful and the destruction of the soil covering which it brings about cannot continue for long, as has been recently pointed out by the Conservator of Forests (*Emp. Jr. of Forestry*, 12. 16). A similar problem came under the consideration of Dr. Mann some years ago in Bombay, where the 'rab' process, which consists essentially of burning a large quantity of branches, leaves, dried grass and cattle dung on the rice seedbeds as an essential part of their preparation, was causing some concern to Government from its destructive effect on the forests. Mann and his co-workers were able to show (*Mem. Dept. Agric. Ind. Chem. Series* 2. 141) that 50 per cent of the effect of this process could be ascribed to the heating, and 40 per cent. to the manurial value of the ash and other material added. By using safflower cake to replace the latter, it was shown that the effect of the former could be obtained by a far smaller quantity of combustible material used in a more economical way. It may be possible to evolve similar methods to deal with the situation in Nyasaland; some, such as the use of cotton seed meal to keep up the fertility, are indicated. Even here, the writer shows that procedure is by no means uniform, and that wide differences exist between the best and the worst methods in their relation to the problem of erosion.

To combat the evil, a system of ridge-terracing, first suggested by the author in 1924, has been worked out, largely no doubt through the experience gained at the Makwapala station of the Empire Cotton Growing Corporation, and it is claimed that it will reduce erosion to a vanishing point. Part II of the bulletin is devoted to a detailed description of this and other devices which may be used for the same purpose, and contains many valuable hints.

R.C.W.

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The South African Sugar Year Book and Directory, 1934.

H. O. Andrews. *S. A. Sugar Journal*, South Africa, 1934. pp. 336, price 5*s*.

In its fifth consecutive year of issue, this valuable handbook will once again find a useful place in the sugar technologist's library. The first part is devoted to a miscellany of articles and notes on many aspects of sugar production submitted by various authorities and firms. Field and factory statistics, reports on growth and production of different varieties, and sundry articles of more general interest such as locust control work, the World Economic Conference and the origin of Uba cane in Natal—these and much other useful material may be found in this compact volume. The second and smaller part forms the Directory, consisting of alphabetically arranged and well-indexed information regarding the personnel, situation, production and other statistics of all the principal factories. The printing and general arrangement is of a high order.

N. W.

* * *

Guide to the Refrigeration Exhibition.

By T. C. Crawhall and B. Lentaigne, Board of Education. Science Museum. *His Majesty's Stationery Office*, London, 1934, pp. 28. 2nd Edition. Price 6*d*.

This booklet is a guide to the refrigeration exhibition on view at the Science Museum, London, from April to August, 1934. It contains "a brief account of the historical development of the exhibits, with notes on the basic scientific principles." Written in simple language it gives a short description of the experiments which have led to modern refrigeration practice, supplemented by diagrams showing the temperatures for storage and transport of various foodstuffs and a theoretical vapour compressor machine; also photographs of models of a refrigerated ship, a hop kiln adapted for gas storage of fruit, and a Mine-Shaft Sinking through water-bearing strata using refrigeration.

E. R. L.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Most suitable conditions for the Decolorization of Juices and Syrups by SO_2. *O. Spengler, F. Tödt and St. Böttger.*

In an investigation of the most suitable conditions for the decolorization of juices and syrups by SO_2, it was found in all the experiments made that the first part of the addition—up to about 0.03 to 0.05 of SO_2 per cent. Brix—has a particularly powerful effect. Beyond this only a small decolorization occurs. It is only with very great additions, such as cannot be considered in practice, that an appreciably greater diminution of colour is to be observed.

It is not possible to state to which alkalinity one should sulphite in practice, since decolorization depends mainly on the nature and the amount of the colouring substances. Especially striking is the fact that both with small and with great additions, the SO_2 is only partly utilized, though reducible substances may still be present. This can probably be explained by stating that the reduction of certain colouring substances is only possible when the mount of SO_2 present has reached a certain amount.

Of the three reducing agents examined, SO_2 was found to act the best for both juices and syrups; next to it came sodium bisulphite; and lastly sodium sulphite.—(*Inter. Sugar Jour.*, Vol. XXXVI, No. 426, 1934, p. 239.)

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The Production of Glucose and Alcohol from Wood.

The production of alcohol from wood is not a new process, and a plant was established as long ago as 1910 in the United States, employing waste shavings from a sawmill as raw material, and dilute sulphuric acid as the saccharification medium. The production of alcohol became important in Germany during the war, and various plants were laid down. The newest is that at Mannheim-Rheinau, and this has recently been described before the Institution of Chemical Engineers by Friedrich Bergius.

The wood, which normally contains from 20 to 40 per cent. of moisture, is first cut in special shredders and mills, and is then dried in a revolving drier until it contains about one per cent. of moisture. The heat for drying the wood is furnished by the waste heat of the boilers. Before being introduced into the diffusers, the dry wood is moistened with a solution coming from the last diffuser containing sugar and hydrochloric acid, and is then transported to the diffuser No. 1, and dropped in through the top opening. After allowing a short time for the reaction to take place in this newly-filled diffuser, No. 1, fresh, highly concentrated hydrochloric acid is pumped into the last diffuser, No. 8. The liquid contained in this diffuser is then transported to diffuser No. 7, the solution from No. 7 to No. 6, and so on. The solution at the top of diffuser No. 1, containing normally about 35 per cent. of sugar, is drawn off to the distillation plant, and a new filling operation may then be started. Vessel No. 8 is washed out systematically, giving a solution with from 37 to 38 per cent. of hydrochloric acid, which is then led to the regeneration plant.

The syrup from the distillation apparatus containing approximately 55 to 65 per cent. of sugar, is dried by hot air. The syrup is injected, together with compressed air, hrough a nozzle. The hot air is blown into the shaft of the evaporator, whence the solid sugar in finely-divided form enters a cyclone, in which separation takes place. The dry sugar drops into the bottom of the cyclone separator, and is drawn off, while the air containing water and hydrochloric acid gas leaving the plant is washed.

The raw sugar in its primary form after neutralizing, can be used as a carbohydrate cattle food. It must undergo inversion before it can be fermented, but this inversion is a very simple and inexpensive process. To produce alcohol, only the hexoses can be fermented, so that 100 kg. of reducing sugar yield about 52 liters of 100 per cent. alcohol; normal cane sugar yields about 60 liters. Other fermentation products, such as lactic acid, can also easily be produced from this product.—(*Ind. & Eng. Chem., News Edition*, Vol. XII, No. 7, 1934, p. 121.)

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***Variations in Mineral Content of Cane with Age and Season.**—*By A. Ayres.*

The ash content of cane varies greatly with different varieties, and in the same variety according to age, season, climate and soil. Numerous analyses made on H 109 show that young cane, taken as a whole, contains relatively more ash (on a percentage basis) than mature cane. Between the ages of one and three months the content of phosphoric acid and potash in the dry matter of the leaves decreases by approximately 40 per cent., that of magnesia rises by some 35 per cent., lime by 145 per cent. and silica by 175 per cent.

The composition of the stalk in the vicinity of the growing point (top six inches) is very different from that of any other part of the plant. While ash content in remote parts of the plant is in the neighbourhood of one per cent., it runs as high as 12.5 per cent. of the total dry matter of the growing point. Here are to be found the highest concentrations of nitrogen, calcium, magnesium, phosphorus and potassium; nearly half is potash.

As we pass down the stalk we find that the proportion of potash rapidly decreases at first, and then more slowly as the base of the stalk is approached, whereas in this part the proportion of silica and phosphoric acid increases.—(*Int. Sugar Jr.*, Vol. XXXVI, No. 425, 1934, pp. 198.)

* Abstracted from the International Society of Sugar-Cane Technologists.

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

"Vici Special" Leather.

The Mellon Institute of Industrial Research has investigated recently the properties of "Vici Special" leather, a product prepared by the impregnation of the leather fibres with material that not only imparts a permanent lubricating action against leather-fibre wear, but continually supplies a surface that is readily polished during service. This property of "Vici Special" leather simplifies the dressing requirements in the shoe factory and is of particular concern to the wearer of shoes from the viewpoint of convenience as well as economy. Shoes made of "Vici Special" leather can be polished by simply rubbing with a soft cloth, or when badly soiled, by first wiping with a solution of castile soap and water.

The "repolishability" property was measured in a drum apparatus in which the samples or shoes were secured to the inside of the rim. These samples were subjected intermittently to the flowing abrasive action of loose sand while the drum turned at the rate of 18 revolutions a minute. Each test was continued for 20,000 revolutions, during which the samples passed through the equivalent of 9.8 miles of sandy beach path. The worn samples were wiped with a damp cloth and then polished with a soft cloth by simple rubbing. The experimental findings and results of practical tests showed that "Vici Special" leather was capable of retaining its property of easy polishing even after long and severe abrasion treatment.—(*Chem. and Ind.* Vol. 53, 1934, No. 17. p. 370.)

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Flaked Coffee.

In merchandising coffee, three methods are commonly employed in an attempt to give the consumer fresh coffee: (1) roasted whole-bean coffee is ground in the store to the purchaser's orders; (2) freshly roasted coffee is ground and hermetically sealed in exhausted containers, and (3) freshly roasted and ground coffee is packed in a closed but not gas-tight container and sold with an expiration date, beyond which its freshness is not guaranteed. Coffee aroma is a complex mixture of volatile compounds formed by roasting (pyrolysis) of the components of the green coffee bean. The soluble non-volatile principles of the bean likewise undergo pyrolysis, resulting in the production of caramel-like substances that give body to the brew prepared from the roasted coffee. Coffee also contains a fatty oil that undergoes some alteration during roasting. The changes that produce stale coffee are, in decreasing order of importance, volatilization of aroma, oxidation of aroma, and oxidation or rancidity of the coffee oil. During the roasting of coffee, there is a copious production of gas in which carbon dioxide predominates. In addition to the gas that escapes during the roasting, a considerable portion is retained in the roasted bean by occlusion. Ground freshly roasted coffee contains approximately five times its volume of this gas, which slowly escapes as the coffee ages, sweeping out a large proportion of the aroma. When attempts are made to preserve the freshly roasted coffee by immediate hermetic sealing, the accumulating gas produces such a pressure as to rupture the container, unless one of special strength is provided. If, on the other hand, the container is vacuumized, the occluded gas is by no means completely removed during the operation, permitting the building-up of some gas pressure within the container, which escapes upon opening, carrying with it at the same time the aroma with which it has become saturated.

It has been found that the application of high pressure to ground, freshly roasted coffee brings about the expulsion of about 90 per cent. of the occluded gas, with practically no loss of aroma. This pressure is most conveniently applied by means of a roller mill. At the same time the coffee particles are converted into thin, flat, coherent flakes, averaging about 0.06 inch in diameter and about 0.003 inch in thickness. By this flaking operation the soluble constituents of the coffee become instantly accessible to the extracting liquid, resulting in the quick extraction of all the water-soluble constituents. Coffee thus processed may be hermetically sealed in containers in which the air is replaced by carbon dioxide, and samples have remained fresh for a period of two years. Because of the accessibility of the soluble constituents in these flakes, extraction is not only much more rapid, but is also more uniform and much more complete. When coffee flakes are brewed in a coffee percolator or in a drip coffee pot, the strength of the brew obtained in even less than the customary period of time is such that the amount of coffee required is materially reduced. Flaked coffee yields during brewing operations approximately 50 per cent. more extractive than is obtained from the customary drip, and from 75 to 100 per cent. more than is had from the ordinary percolator.—(*Ind. & Eng. Chem., News Edition*, Vol. XII, No. 8, 1934, p. 142.)

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Motor Spirit from Water Hyacinth.

Experiments are being made in Calcutta with a view to the cheap production of a motor spirit from the Water Hyacinth plant (*Eichhornia*), which grows very abundantly in the waterways of Bengal as well as in lakes, ponds and streams in most tropical countries. By bacterial decomposition, about 24 gallons of motor spirit can be obtained from one ton of the plant, at an approximate cost of 0.5 pence per gallon. During the process, a gas of hydrocarbon nature is released; this presumably might be used as a combustible material for distilling off the spirit. The solid residue after fermenting is said to furnish an excellent manure.—(*Chemistry and Industry*, 1934, p. 313.)

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Market have ranged as follows (c.i.f. per cwt.)

	Foreign.		*Preferential.*	
	s.	*d.*	*s.*	*d.*
31st May	4	7½	8	7½
7th June	4	7½	8	7½
14th June	4	7½	8	9
21st June	4	7½	8	9¾
28th June	4	7½	8	7½
5th July	4	10½	8	9
12th July	4	10½	8	6
(13*th July*, 1933)	5	7½	10	4½

Two prominent factors in the sugar situation have been the continued reserved attitude amongst producers, and the abnormal dry weather conditions. Buyers on both sides of the Atlantic are awaiting a more definite market "pointer", but in spite of expectation of a further reduction in the Cuban tariff, and the coming into force on 8th June of the new Processing Tax of 50 cents per 100 lb. Raw Sugar, a fair day-to-day demand has been in evidence in the Refined market.

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows:

	d.
30th May	5 7-8
6th June	6 1-4
13th June	6 9-16
20th June	6 9-16
27th June	6 3-4
4th July	6 3-16
11th July	7 3-16
(12*th July*, 1933)	3 3-4

Adverse circumstances such as threats of strikes in the United States motor and steel trades, and a tendency to form speculative pools or syndicates operating in Rubber in certain quarters have had surprisingly little effect on the market which has throughout remained steady. A possible explanation is the conviction amongst buyers that with the Regulation Scheme in existence Rubber is now under-valued, and that present purchases will look cheap within a reasonably short space of time.

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BANANAS.—Jamaicas have continued in good demand during the fortnight. Today's prices (per ton to wholesalers) are as follows:—

	Delivered London.		*Nearest Station Provinces.*	
	£	s.	£	s.
Jamaica Producers	20	5	20	0
Elders & Fyffes	19	5	19	0

Brazilians are also in good demand at the unchanged price of £18 per ton nearest station.—(*West India Committee Circular* 7th June.)

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association:—

	American Mid.	*Egyptian F.G.F. Sakel.*
25th May	6.20	8.42
1st June	6.26	8.41
8th June	6.56	8.55
15th June	6.61	8.35
22nd June	6.69	8.41
29th June	6.78	—
6th July	6.81	—
13th July	7.03	—
(14*th July*, 1933)	6.33	8.38

Prices advanced slightly as a result of fears that the drought in the Wheat Belt would extend to the Cotton Belt, and the market generally is showing itself very sensitive to crop developments. Recent prices show little change in spite of fluctuations and latest reports indicate no material alteration in conditions over the Cotton Belt.

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COCOA.—Despite fairly heavy stocks of cocoa in New York the Exchange market there continues firm. Generally, however, the market is at the present time under the influence of the situation in Germany where the exchange quota is only ten per cent. of the basis amount. This means that firms with a turnover of 100,000 Marks in foreign currency formerly, can now only apply for ten per cent. *i.e.*, 10,000 Marks or the value of 25 tons of Accra cocoa. Imports, therefore, are practically stopped from this market which is the second largest consumer of cocoa in the world. Superior Summer Arriba is quoted at 39*s*. London Landed Terms and Accra at 25*s*. 9*d*. whilst locally $7.00 a fanega is paid for good Plantation.—(*By Courtesy of the Cocoa Planters' Association of Trinidad.*)

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COPRA—is quietly steady with West Indian f.m.s. quoted at £9 5*s*. to £9 7*s*. 6*d*. c.i.f. London. —(*West India Committee Circular* 7th June.)

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LIME PRODUCTS:—*Lime Oil.*—Handpressed is unchanged with sellers at 32*s*. 6*d*., but little interest is shown by buyers. The nominal quotation of Distilled remains at 23*s*., but to effect sales of important quantities considerably less must be accepted. Pressure of new crop from shippers is helping to weaken the market. *Lime Juice.*—In concentrated a further small business has been done at £4 10*s*. Spot supplies of Raw are scarce and valued at 2*s*. to 2*s*. 8*d*. per gallon.—(*West India Committee Circular* 7th June.)